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Zoroufy

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(54) CORNER MOUNTED ILLUMINATOR

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(21) Appl. No.: 09/393,513

(22) Filed: Sep. 10, 1999

(51) Int. Cl.[7] F21V 11/00

(52) U.S. Cl. 362/368; 362/362; 362/147; 362/190

(58) Field of Search 362/183, 190, 362/191, 192, 146, 147, 368, 362

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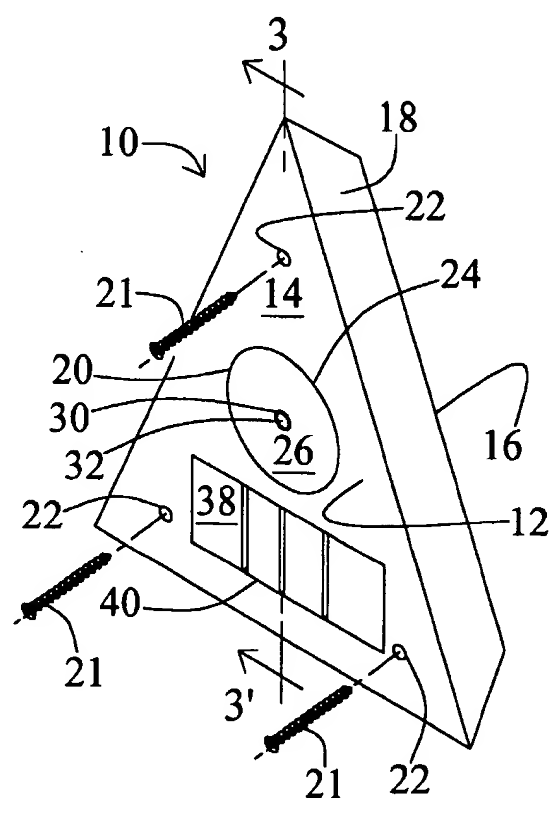
(57) ABSTRACT

A corner accentuator or corner mounted illumination for providing illumination from the corner of two walls. The accentuator includes a light-illuminated reflector in the front side of a corner plate. The light has a DC power source that can provide power to the light even in when there is a power outage. The power source can be used in conjunction with a solar collector disposed in the front side of the corner plate which recharges the energy storage device.

18 Claims, 3 Drawing Sheets



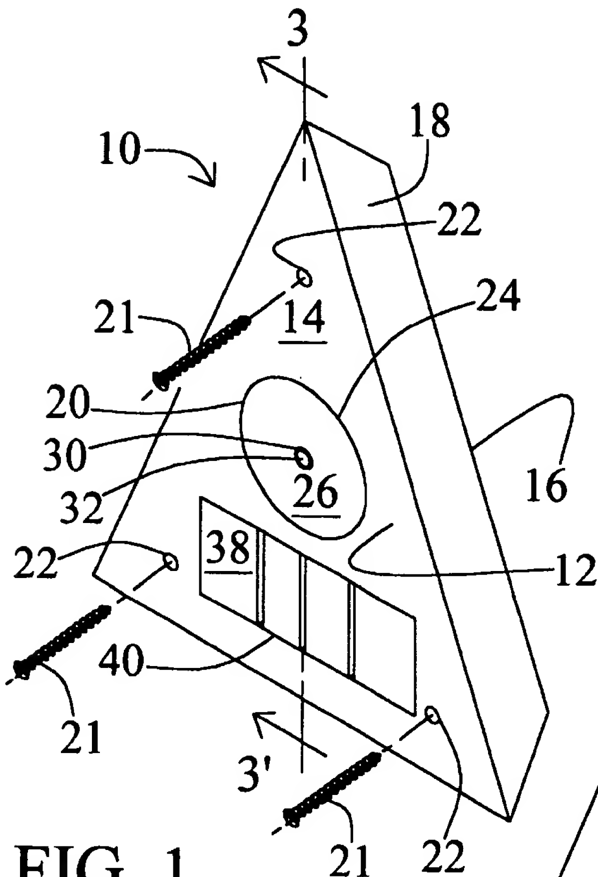

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FIG. 1

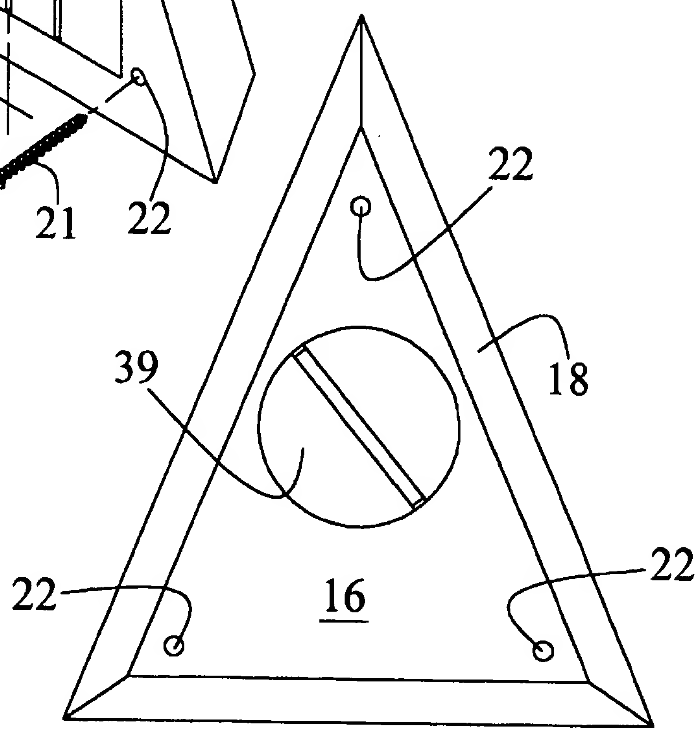
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FIG. 2

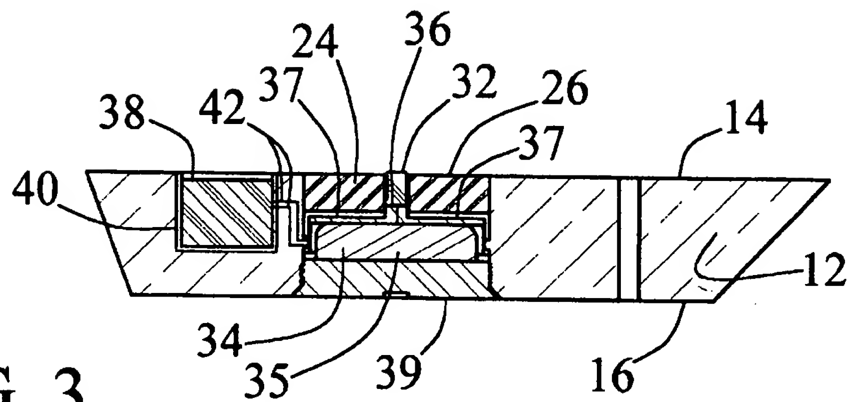
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FIG. 3

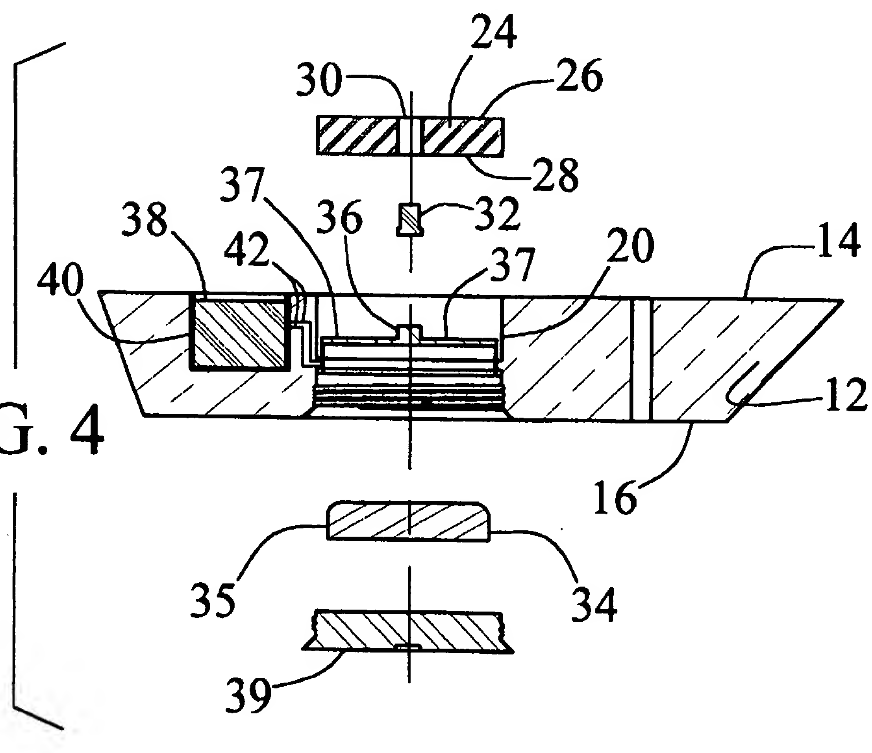
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FIG. 4

FIG. 5

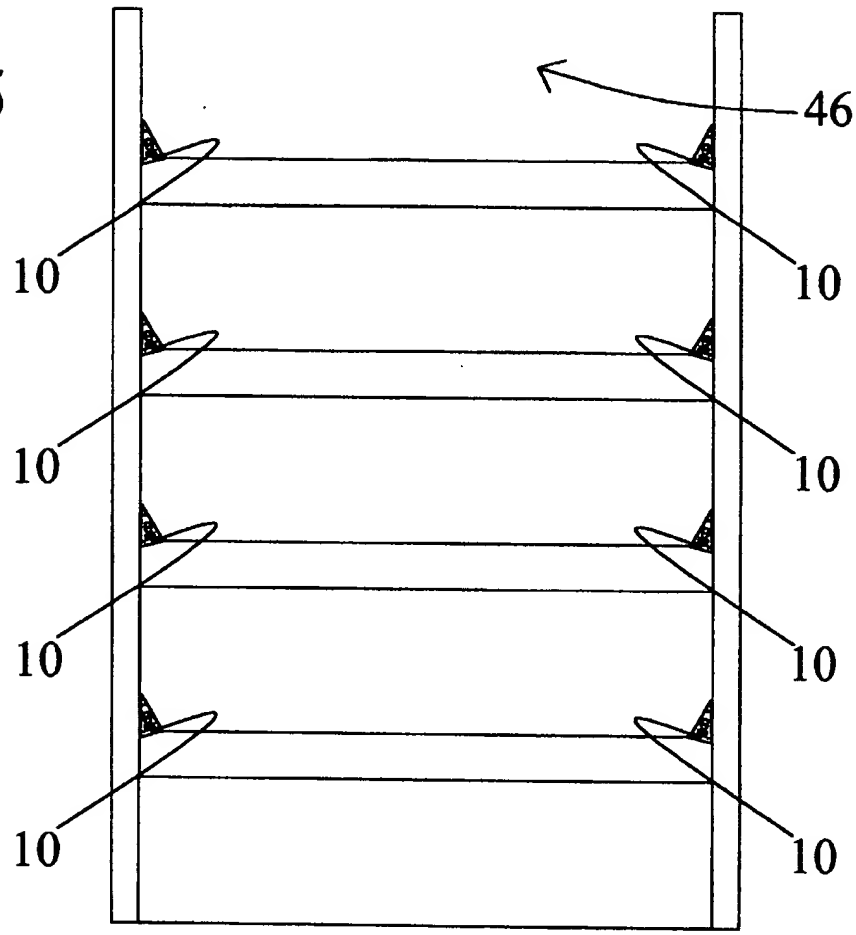
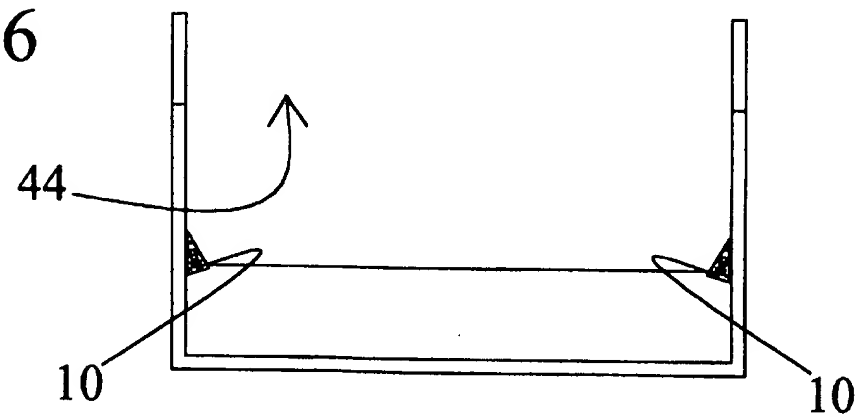


FIG. 6



CORNER MOUNTED ILLUMINATOR

CROSS-REFERENCE TO RELATED APPLICATIONS

Not applicable.

STATEMENT REGARDING FEERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable.

BACKGROUND OF INVENTION

The present invention relates generally to an apparatus for providing illumination from a corner. More particularly, the present invention provides illumination from an apparatus attached to a corner of two connecting walls, thus providing illumination that defines boundaries of rooms, hallways, stairs and other indoor areas in low light or no light conditions.

The interiors of homes, offices, and other buildings frequently experience low light conditions. Low light or no light conditions in interior areas pose a considerable safety concern, as people moving through such areas can harm themselves through collision or fall.

Low light conditions can be the result of inadequacies in standard fixture lighting or can be due to emergency situations, such as power failure. In dark or dimly lit conditions, standard fixture lighting systems pose a problem in that they are often controlled by switches, that are often difficult to locate to turn on the desired lights. In power failure situations, of course, turning on a light switch does not usually remedy the lighting problem.

A further problem with standard fixture lighting systems is that the light provided by such systems are often inadequate for illuminating various structural features in an interior area, such as stairs and corners. Standard fixture lighting systems are most commonly placed on, or adjacent to, the ceiling of interior areas. The placement of lighting systems in such locations often results in the production of heavy shadows and other such unwanted lighting effects with regards to stairs and corners.

There are, of course, numerous emergency lighting systems currently available or power failure conditions, yet they all contain certain features which are undesirable. The most common emergency lighting system is one which is hardwired into the AC electrical system of a building, and contains a DC power source which is charged by AC electrical power. Such emergency lighting systems use AC power until a time when such power is unavailable. The systems then draw power from their DC source. U.S. Pat. No. 4,977,351 issued to Bavaro et al. and U.S. Pat. No. 5,365, 145 issued to Fields disclose such systems. The drawbacks to these types of systems, include, for example, complex installation requiring the emergency lighting system to be physically hardwired into the AC electrical power source in the building. Professional electricians are often required to install such systems. This makes installation of such systems expensive and time-consuming.

More importantly, most emergency lighting systems are often large and unattractive. The size and design of most systems is a necessary trade off for the functionality of providing enough power (usually though a large battery unit) for a light generating source to emit a bright light within a space. The size of many of these systems makes it difficult to mount them externally in stairs and corners.

Some prior art systems have attempted to specifically respond to the problem of illuminating, e.g., corners, stairs,

etc., in low light or no light condition. These lighting systems designed to better illuminate such areas also often have many drawbacks. Such lighting systems are often required to be embedded in walls, stairs, and floors of the building itself so as not to obstruct the walkways of individuals. U.S. Pat. No. 4,394,714 issued to Rote and U.S. Pat. No. 5,813,468 issued to Shimada, both disclose lighting systems for stairs which require the systems be built into the steps themselves. Such lighting systems are difficult and costly to install in an existing set of stairs.

Thus, a need exists for an attractive and effective illumination device for corners which can function independent of AC power, is inexpensive, and is easy to install.

SUMMARY OF THE INVENTION

The present invention provides a corner accentuator or illuminator which is self-illuminating for providing illumination from a corner. The accentuator in accordance with the resent invention is aesthetically pleasing, inexpensive, small, unobtrusive and easy to install. The device is electrically self-contained requiring no external electrical wiring.

The foregoing and other advantages of the present invention are realized in one aspect thereof in a corner accentuator for providing illumination from a corner, comprising a unitary structure configured and dimensioned to fit in a corner. The accentuator includes a corner plate having a front side, a back side, a perimeter edge separating said front and back side, and an aperture therethrough; a reflector having a front reflective side, a back non-reflective side, and a reflector aperture; a light source; and an energy storage device electrically connected to the light source.

The plate is mounted in a corner such that it prevents the buildup of dust in corner areas, which are generally hard to reach with cleaning devices. The perimeter edge of the plate is beveled so that the plate fits easily and snugly into a corner to prevent dust from building up in the corner. The corner plate is mounted in a corner so that the front side of the plate faces the room, and the back side of the plate faces the corner. The reflector is mounted within the aperture in the corner plate so that the front reflective side faces the same outward direction as the front side of the corner plate. The light source is mounted within the reflector aperture such that the light source projects light onto the surface of front reflective side of the reflector. The illumination provided by the light source is concentrated and redirected by the reflector providing a bright source of illumination that alerts an individual of the location of the reflector, and therefore, the location of the corner. The energy storage device is mounted proximate to the back side of the corner plate.

In another aspect of the present invention, the energy storage device is charged by a solar powered collector, e.g., a photovoltaic cell. Such a collector is disposed within the recess aperture in the corner plate and is operatively connected to charge the energy storage device for the purpose of keeping it charged.

In further aspect invention, the corner plate is secured thereby to a corner. In another embodiment, the invention can be secured to a corner by using a fastener, e.g., a nail or a screw, that passes through connection apertures in the plate, or by applying adhesive to the perimeter edge.

In another aspect, the invention provides a lighting system which includes a pair corner accentuators used in tandem. In the system, one of the corner accentuators is mounted on the corner of a wall, a stair and the other in an opposite corner. This provides a bright light source that alerts an individual,

in low light conditions, of the perimeter and boundaries of the wall. Such a wall can be the wall of a room, hallway, back of a stair, or the like.

In yet another aspect, the invention provides a method of illuminating and defining the steps of a stairway, which includes the steps of securing to each corner of a step a corner accentuator, the corner accentuator including a corner plate having a front side, a back side, a perimeter edge separating said front and back side, and an aperture therethrough; a reflector having a front reflective side, a back non-reflective side, and a reflector aperture, the reflector being mounted within the first aperture; a light mounted within the reflector aperture; and an energy source proximate the back side of the corner plate, and proximate to and electrically connected to the light.

Other advantages and a fuller appreciation of the specific attributes of this invention will be gained upon examination of the following drawings, detailed description of preferred embodiments, and appended claims. It is expressly understood that the drawings are for the purpose of illustration and description only, and are not intended as a definition of the limits of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The preferred exemplary embodiments of the present invention will hereinafter be described in conjunction with the appended drawings wherein like designations refer to elements throughout and in which:

FIG. 1 is a perspective view of the unitary structure in accordance with the present invention;

FIG. 2 is a back view of the structure of FIG. 1 in accordance with the present invention;

FIG. 3 is a side sectional view of the structure of FIG. 1 along line 3—3';

FIG. 4 is an exploded view of FIG. 3;

FIG. 5 is a perspective view of the lighting system in accordance with the present invention being utilized in stair case; and

FIG. 6 is a perspective view of the lighting system in accordance with the resent invention being utilized in a hallway.

DETAILED DESCRIPTION

The present invention relates generally to an apparatus for providing illumination from a corner. The present invention is more particularly adapted for providing dust protection for a corner as well as providing illumination from a solar powered corner accentuator. Accordingly, the present invention will now be described in detail with respect to such endeavors; however, those skilled in the art will appreciate that such a description of the invention is meant to be exemplary only and should not be view as limitative on the full scope thereof

In accordance with the present invention, corners are illuminated by a corner accentuator which is positioned in the corner of walls, steps of a stairway, etc. The corner accentuator of the present invention is characterized by several attributes: it is attractive, simple, compact, long-lasting, can function independent of AC power, inexpensive, and is easy to install. These attributes are achieved through a particular structural arrangement meeting special combination of physical parameters.

As used herein, the term "corner" is meant to refer to the vertex of three substantially perpendicular walls, panels or surfaces, and "corner plate" refers to a plate adapted to fit in a corner, typically a triangular-shape plate

Reference is initially made to FIGS. 1–4 depicting a corner accentuator **10** in accordance with the present invention. Accentuator **10** has an unitary structure which includes a corner plate **12**. Corner plate **12** has a front side **14**, a back side **16**, a suitably beveled perimeter edge **18**, and an aperture **20**. The corner plate **12** is preferably made out of a strong sturdy material, that is also attractive. Metal is suitable, preferably brass. Brass can give a polished attractive look to the front side **14** of the corner plate **12**, while providing the strength to withstand vibrationally impact by passing foot traffic, especially when used on a step.

The perimeter edge **18** of the corner plate **12** is beveled at such an angle that the plate can fit easily and snugly into a corner. An adhesive, such as two sided tape, or epoxy, may be suitably affixed to the beveled perimeter edge **18** of the corner plate **12** and allow for quick, easy, and effective mounting in a corner. Alternatively, fasteners **20**, such as nails or screws, can be used to mount the corner plate **12** into a corner. As such, the corner plate **12** may suitably have a plurality of connection apertures **22** that allow nails or screws to pass through the plate and secure the plate to a corner.

Referring specifically to FIGS. **3** and **4**, aperture **20** in the corner plate **12** provides an area for a reflector **24** to be received therein. The reflector **24** has a front reflective side **26**, a back non-reflective side **28**, and an aperture **30**. Reflector **24** may be produced from any transparent solid. Molded plastic is preferred as it has a high refractive index. Moreover, molded plastic reflectors can be produced at a relatively low cost and are commercially readily available.

The reflector **24** is mounted within aperture **20** of the corner plate **12**. It is mounted so that front reflective side **26** faces the same outward direction as front side **14** of the corner plate **12**. Reflector **24** is suitably mounted to the corner place by use of an adhesive, e.g., an epoxy adhesive.

Aperture **30** in the reflector **24** provides an area for a light source **32** to be received therein. The light source **32** is mounted within aperture **30** of the reflector **24**, preferably by an adhesive, so that light source **32** projects light onto the surface of the front reflective side **26** of the reflector **24**. This configuration spreads light over a relatively wide surface of reflector **24**, thereby promoting visibility at great distances and at varied angles.

Light source **32** is suitably a low voltage lamp, preferably a high intensity light emitting light emitting diode (LED) that emits optical radiation in the visible regions. Alternatively, an incandescent lamp may be used for light source **32**.

Light source **32** is electrically connected to an energy storage device **34**. The connection may be made via a contact tab made of a conductive material and designated as **36**. The energy storage device **34** is suitably mounted behind light source **32**, being held by clips **37**. Aperture **20** is provided with a removable cover **39** which is suitably threadedly secured to the back side **16** of corner plate **12** to cover aperture **20**. The energy storage device **34** is suitably a battery **35**, and preferably, a rechargeable battery, such as a nickel cadmium or lithium battery.

As shown in FIGS. **3** and **4**, an alternative arrangement of the invention makes use of a solar collector **38** to charge the energy storage device **34**. A recess **40** in the front side **14** of the corner plate **12** provides an area for the solar collector **38** to be received therein. The solar collector **38** is disposed within recess **40** of corner plate **12**, and is further connected

to the energy storage device 34 by connectors 42 the collector 38 is suitably mounted within recess 40 with e.g. an epoxy.

It is understood that a simple control circuit is suitably employed to illuminate light source 32 and charge battery 35. A schematic diagram of one such circuit is found in U.S. Pat. No. 4,668,120, the disclosure of which is incorporated herein by reference. The circuit shown in U.S. Pat. No. 4,668,120 is merely exemplary and those skilled in the art will recognize that illuminating and recharging may easily be created using a circuit similar to the one shown, or a circuit completely different from this one shown.

Referring now to FIGS. 5–6, a perspective view shows a lighting system using a pair of corner accentuators 10 being used in tandem along the same wall. By positioning the accentuators 10 in opposite corners of the same wall, the light provided by the accentuators provide a viable boundary of a wall in low light conditions. Such a wall, might be a wall to a room 44, or a wall defining the back of a stair 46.

While the present invention has now been described and exemplified with some specificity, those skilled in the art will appreciate the various modifications, including variations, additions, and omissions, that may be made in what has been described. Accordingly, it is intended that these modifications also be encompassed by the present invention and that the scope of the present invention be limited solely by the broadest interpretation that lawfully can be accorded the appended claims.

What is claimed is:

1. A corner mounted illuminator for providing illumination from a corner, said illuminator comprising a unitary structure configured and dimensioned to fit in a corner, and said illuminator further comprising:

a. a non-translucent corner plate having a front side, a back side, a perimeter edge separating said front and back side, and a reflector aperture therethrough;

b. a reflector having a front reflective side, a back non-reflective side, and a light source aperture, said reflector being mounted within the reflector aperture to said corner plate;

c. a light source mounted within the light source aperture between the back side and the front side of the corner plate; and

d. an energy storage device electrically connected to said light source, and mounted proximate to the back side of said corner plate.

2. The corner mounted illuminator of claim 1 wherein said energy storage device is a rechargeable battery.

3. The corner mounted illuminator of claim 1 wherein said light source is a light emitting diode.

4. The corner mounted illuminator of claim 3 wherein said energy storage device is a rechargeable battery.

5. The corner mounted illuminator of claim 1, further comprising:

a. said corner plate having a solar collector recess in said front side; and

b. a solar collector disposed within said solar collector recess, said solar collector operatively connected to charge said energy storage device.

6. The corner mounted illuminator of claim 5 wherein said light source is a light emitting diode.

7. The corner mounted illuminator of claim 5 wherein said energy storage device is a rechargeable battery.

8. The corner mounted illuminator of claim 1 or 5 further comprising attachment means for securing said unitary structure to a corner.

9. The corner mounted illuminator of claim 8 wherein said energy storage device is a rechargeable battery.

10. The corner mounted illuminator of claim 8 wherein said attachment means includes at least one connection aperture through said corner plate for passing a fastener to secure the corner plate to a corner.

11. The corner mounted illuminator of claim 10 wherein said energy storage device is a rechargeable battery.

12. In a wall having opposite corners formed by the vertex of three mutually perpendicular walls, a lighting system comprising a pair of corner mounted illuminators, one of said pair disposed in one corner, and the other of said pair disposed in an opposite corner, said corner mounted illuminator comprising:

a. a non-translucent corner plate having a front side, a back side, a beveled perimeter edge therebetween, and a reflector aperture therethrough;

b. a reflector having a front reflective side, a back non-reflective side, and a light source aperture, said reflector being mounted within the reflector aperture;

c. a light source mounted within the light source aperture between the back side and the front side of the corner plate; and

d. an energy storage device proximate said back side of said corner plate, and proximate to and operatively connected to said light source.

13. The lighting system of claim 12 wherein the corner mounted illuminator further comprises:

a. the corner plate having a recess; and

b. a solar collector disposed within the recess, said solar collector operatively connected to charge said energy storage device.

14. A corner mounted illuminator, comprising:

a non-translucent triangular plate configured and dimensioned to fit in a corner, and having a front side, a back side, a perimeter edge therebetween, a reflector aperture therethrough and a recess in said front side;

a reflector having a front reflective side, a back non-reflective side, and a light source aperture, said reflector being mounted within the reflector aperture;

a light mounted within the light source aperture between the back side and the front side of the corner plate;

an energy storage device proximate said back side of said triangular plate, and proximate to and electrically connected to said light; and

a solar collector disposed within the recess of the triangular plate, said solar collector operatively connected to charge said energy storage device.

15. A corner mounted illuminator, comprising a non-translucent corner plate, a reflector, a light and a DC voltage source;

said corner plate having a front side, a back side, a perimeter edge separating said front and back side, and a reflector aperture;

said reflector having a front reflective side, a back non-reflective side, and a light source aperture, said reflector being mounted within the reflector aperture;

said light mounted within the light source aperture between the back side and the front side of the corner plate; and

said DC source proximate said back side of said corner plate, and proximate to and electrically connected to said light source.

16. A method of illuminating and defining the steps of a stairway, comprising:

securing to each corner of a step a corner mounted illuminator; said corner mounted illuminator including:

a non-translucent corner plate having a front side, a back side, a perimeter edge separating said front and back side, and a reflector aperture therethrough;

said reflector having a front reflective side, a back non-reflective side, and a light source aperture, said reflector being mounted within the reflector aperture;

said light mounted within the light source aperture between the back side and the front side of the corner plate; and

said energy source proximate said back side of said corner plate, and proximate to and electrically connected to said light.

17. A corner mounted illuminator for providing illumination from a corner, said illuminator comprising a unitary structure configured and dimensioned to fit in a corner, and said illuminator further comprising:

a. a non-translucent corner plate having a front side, a back side, a perimeter edge separating said front and back side, and a reflector recess on the front side;

b. a reflector having a front reflective side, a back non-reflective side, and a light source aperture, said reflector being mounted within the reflector recess to said corner plate;

c. a light source mounted within the light source aperture; and

d. an energy storage device electrically connected to said light source, and mounted proximate to the back side of said corner plate.

18. A corner mounted illuminator for providing illumination from a corner, said illuminator comprising a unitary structure configured and dimensioned to fit in a corner, and said illuminator further comprising:

a. a non-translucent corner plate having a front side, a back side, a perimeter edge separating said front and back side, and a reflector recess on the front side;

b. a reflector having a front reflective side, a back non-reflective side, and a light source aperture, said reflector being mounted within the reflector recess to said corner plate;

c. a light source mounted within the light source aperture such that the light source is mounted within said corner plate as opposed to being mounted behind said corner plate; and

d. an energy storage device electrically connected to said light source, and mounted proximate to the back side of said corner plate.

* * * * *

US005136483A

United States Patent [19]

Schöniger et al.

[11] Patent Number: 5,136,483

[45] Date of Patent: Aug. 4, 1992

[54] ILLUMINATING DEVICE

[76] Inventors: Karl-Heinz Schöniger, Barbarossastr. 40/6, 7300 Esslingen; Winfried Scheid, Ringweg 14, 7333 Ebersbach, both of Fed. Rep. of Germany

[21] Appl. No.: 573,895

[22] Filed: Aug. 28, 1990

[30] Foreign Application Priority Data

Sep. 8, 1989 [DE] Fed. Rep. of Germany 3929955

[51] Int. Cl.[5] B60Q 1/00

[52] U.S. Cl. 362/61; 362/31; 362/231; 362/800

[58] Field of Search 362/31, 61, 82, 83, 362/343, 26, 800, 80, 231, 237

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4,965,950	10/1990	Yamada	362/31

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Primary Examiner—Ira S. Lazarus
Assistant Examiner—Sue Hagarman
Attorney, Agent, or Firm—McGlew & Tuttle

[57] ABSTRACT

An illuminating or light emitting device for use as a headlamp, a signaling lamp or other lamp for shining light in a beam or otherwise. It comprises as its main parts a generally flat transparent illuminating element with a circumferential edge in which a plurality of light emitting elements such as LED's are set. The edges are provided with an inwardly reflecting layer. The front side of the illuminating element is in the form of a light radiating surface, while the rear side is completely covered with an inwardly reflecting layer. Such an illuminating device may have a very flat overall shape, has a low current requirement and has a large homogeneous radiating area. It more especially lends itself to use on vehicles.

10 Claims, 1 Drawing Sheet

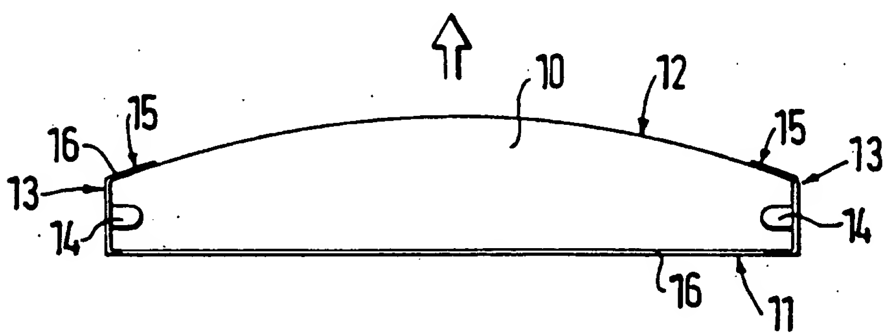


FIG. 1

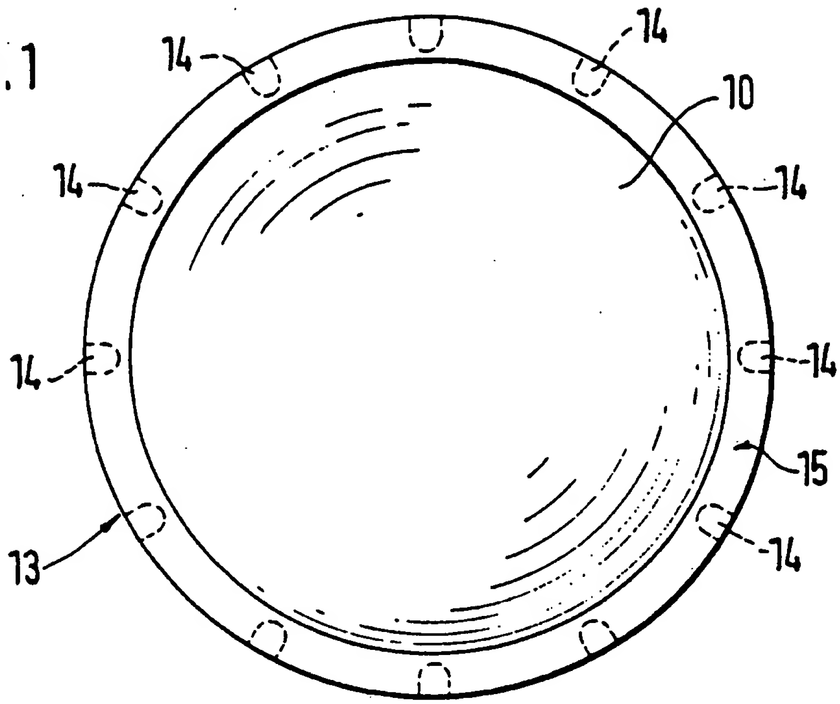


FIG. 2

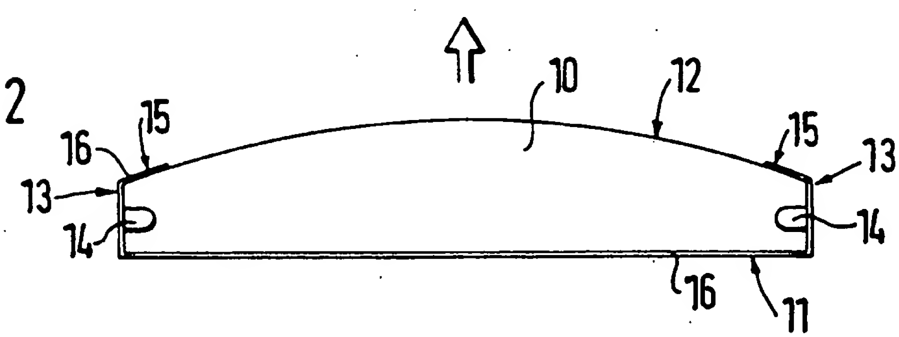
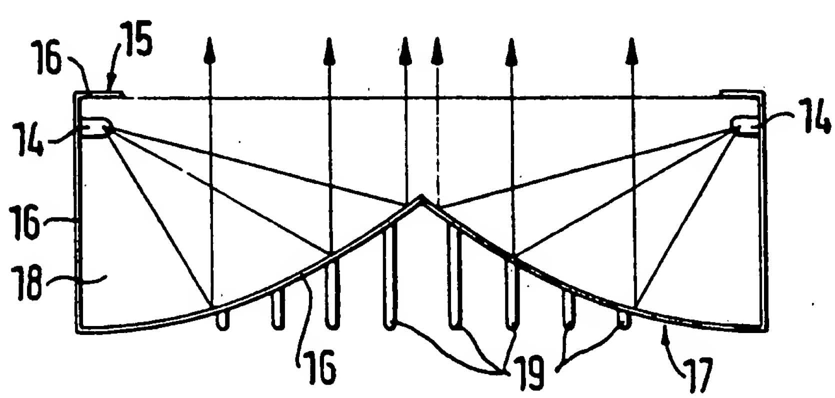


FIG. 3



ILLUMINATING DEVICE

BACKGROUND OF THE INVENTION

The invention relates to an illuminating device such as a headlamp, signaling lamp, that is to say lamps shining light in beam or otherwise, comprising an essentially flat transparent illuminating element with a plurality of light emitting elements such as LED'S set in a marginal edge thereof, such edges being provided with a reflecting layer.

The German pre-examination specification 3,825,436 describes light conducting plates having LED'S arranged at their edges so that the light emerges at rear adhesively attached symbols and illuminates them. The light of the LED'S thus merely serves to illuminate the indicating or advertizing logo and the arrangement may not generally be used as an illuminating device, as for instance in the form of a lamp for shining light onto objects.

Conventional headlights, taillights etc. have an incandescent bulb at the focus of a reflector. One disadvantage of such illuminating devices is that they have a considerable overall depth, this making itself felt more particularly in the case of automobile applications where space is at a premium. Owing to the poor luminous efficiency of incandescent lamps high temperatures occur, which lead to the requirement for a design ensuring heat dissipation by conduction. When an incandescent lamp fails, the illuminating device is no longer able to function so that, more particularly in the case of essential equipment such as headlights and taillights, immediate replacement becomes imperative. However, such a defect may lead to hazardous situations.

There has already been a proposal to arrange a plurality of LED'S in an area to form a vehicle taillight. In this case there is however the shortcoming that in place of a homogeneous illuminating area there is simply a cluster of bright spots.

SHORT SUMMARY OF THE PRESENT INVENTION

Accordingly one object of the present invention, is to provide an illuminating device of the type initially referred to (headlamp, taillight) herein which has a flat overall form.

A still further object of the invention is to provide such an illuminating device which has a high luminous efficiency.

Yet a further object of the invention it so provide such a device which has a relatively equal distribution of the light.

In order to achieve these or other objects appearing from the present specification claims and drawings, the present invention provides a device in which the front side of the illuminating element is in the form of a radiating surface and the rear side is completely covered with a reflecting layer. The plurality of light emitting elements, which are preferably in the form of LED'S, provides that any defect in one LED will only have a very minor effect so that there will be no safety hazards and immediate replacement is not called for. The circumferential edges may be fitted with a very large number of LED'S so that, more particularly in the case of use of modern high output diodes, such a large luminous flux may be produced that use in headlamps, taillights etc. is possible. The arrangement of the electrical leads so that they extend from the LED'S and emerge to the side of the lamp means that a very flat overall design is possible such that the illuminating device may be readily mounted, for instance, on the outside of bodywork of an automobile and furthermore hardly requires any space. Even distribution on the circumferential edges means that the light radiating area is very evenly illuminated, the light being fully directed in a forward direction owing to the completely reflecting layer on the rear side. Emergence of light at the edges is effectively prevented by a further reflecting layer.

Further developments of the invention are described in the claims.

In order to achieve an even more regular distribution of the light in the marginal part having the light emitting elements the front side has a reflecting layer. This means that the light is only able to reach the middle part of the illuminating element so as to be radiated forwards thereby. In order to focus or collimate the light more particularly in the case of headlamps, taillights and the like, it is an advantage if the front side/or the edges and/or the back side of the illuminating element have a form such as to beam or collimate the light. For this purpose the front side is preferably made convex and/or the back side is made conically concave, and/or the edges are made with an essentially concave cross section. In accordance with a further expedient possibility the front side, the edges and/or the rear side of the illuminating element are provided with light collimating humps or recesses. The selection of the means depends more particularly on whether the light is to be radiated in a generally parallel beam or in some required diverging form. The individual features may be combined together to supplement each other or some features may be omitted. Owing to its form the illuminating element leads additionally to a unidirectional or beamed form of the emerging light, that is to say the reflecting layer or, respectively, the mirror coating on the rear side takes the place of a separate reflector and a separate light radiating means with optical elements.

The reflecting layer may be economically and simply produced by sputtering, bonding or by electroplating. In the case of a very high luminous output, that is to say in the case of there being a very large number of high output light emitting elements or diodes, the reflecting layer may be expediently connected with a cooling body or heat sink.

In order to make possible a wider range of designs, the illuminating device may be provided with different-colored LED'S, in which respect, in order to achieve a certain, desired color of the light only those LED'S will be turned on which have this light color or LED'S for different colors will be operated which in combination produce the desired mixed color or secondary color. To take an example, it is possible for red, green and blue LED'S to be used in order to produce white light. By utilizing LED'S of different colors it is thus possible to achieve different effects and to open up different applications for an illuminating device. As an example, the illuminating element may be in the form of a member made of plastic to act as the taillight of an automobile, in which there are also braking, reverse and/or blinker functions. By using different LED'S it is thus selectively possible to produce red, yellow or white light in accordance with the instantaneous function desired. If the illuminating element is in the form of an automobile lamp, as for instance in the form of a parking light, then

it will be obvious that only the white color or, for instance in the case of a French automobile, only the yellow color will be needed. The lamp in accordance with the invention furthermore lends itself to adaptation for use as a construction site lamp on a highway, the LED'S then being caused to flash and being operated at a higher power. When caused to flash the LED'S may be run with an up to tenfold increase in the amperage.

Further features and advantages of the invention will be gathered from the ensuing description of two embodiments thereof referring to the drawings.

LIST OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. 1 is a plan view of an illuminating device in the form of a round headlamp or beam producing lamp.

FIG. 2 is a cross section taken through the headlamp of FIG. 1.

FIG. 3 is a cross section taken through a further illuminating device in the form of a headlamp.

DETAILED DESCRIPTION OF WORKING EMBODIMENTS OF THE INVENTION

In the case of the first working embodiment of the invention shown in FIGS. 1 and 2 a headlamp or lamp for producing a beam of light has at its main parts a transparent illuminating or light emitting element 10, which is made in the form of a round plate of glass or transparent resin such as PMMA. The material may contain fluorescent particles. While the rear side 11 of the illuminating element is made flat, the front side 12 is configured in a convex manner like a converging lens. Twelve LED'S 14 are arranged with a regular spacing on the circumferential edge 13 of the illuminating element 10 and are seated in suitable openings. The number thereof is obviously able to be freely chosen and depends on the luminous flux to be produced. In the case of a headlamp the arrangement may be considerably more crowded than, for instance, in the taillight of an automobile. The rear side 11, the edge 13 and the a strip-like part 14, covering over the LED'S 14 to the front, of the front side 12 are provided with an inwardly reflecting layer 16.

This layer may be produced by sputtering, by the adhesive bonding of a film or by electrolytic deposition so that the respective surfaces are mirrored and the entire luminous flux is reflected thereat and cast back into the interior space.

The convex design of the front side leads to a focussing or collimation of the light as a beam. Dependent on the type of the desired beaming effect various possible designs of the front side are possible, as for instance in accordance with the desired angle of the output beam.

In the case of the second embodiment in accordance with the invention the rear side 17 of an illuminating element 18 is made conically convex, and owing to the round cross section of the illuminating element 18 in the horizontal plane the result is generally a circular cone with a generatrix bowed towards the cone's axis. As in the first embodiment of the invention the LED'S 14 are arranged so as to be distributed about the circumference so as to be respectively at the focus of the reflector which is parabolic or elliptical in cross section and is formed by the rear side 17. As is diagrammatically indicated by arrows, this makes it possible to achieve an essentially parallel output beam. The illuminating or light emitting element 18 in this case not only sets the form of the reflector but also performs the function of conducting the light and acting as a mount for the LED'S 14.

In order to ensure dissipation of heat in the case of a high luminous flux the rear side 17 is provided with annular cooling bodies 19, which are adapted to the conically concave form of the rear side 17. In this case as well it is naturally possible for the annular cooling members to be replaced by other shapes, which may project past and out of the conical concavity if desired. Since LED'S have a very high luminous efficiency and only lead to a low heating effect, such cooling members 19 are only required in the case of a very compact arrangement of the LED'S or if the latter are designed for very high power levels.

Combinations of the two working embodiments as regards the form of the front and rear sides of the illuminating element are also possible, in which respect variations in the configuration of the cross section are possible in order to comply with the manner in which the light is to be put in the form of a beam. In the case of rectangular or oval illuminating devices and of illuminating devices with other horizontal forms of cross section variations in the form of the front and rear sides may be necessary. The edge parts may also have a form differing from that shown in the figures in order to aid in collimating the light and may for example have a concave cross section in order to ensure that the light is shone into the middle of the illuminating element.

In addition to design as an automobile headlamp or as a parking light, such illuminating means may be used for other signaling and illuminating purposes, as for example for combined taillight sets for automobile, that is to say as combinations of a taillight, a braking light, a reverse light and/or a blinker lamp. The same may be made separate or integrated in one illuminating device. In order to produce the different colors of the light needed for this purpose, various colors of LED will be used. Thus red LED'S will be used for the taillight and brake light functions while yellow LED'S will be used for the blinker lights. In order to produce different degrees of brightness for the braking light and the taillight it is possible for respectively different numbers of LED'S to be put into operation. In order to produce white light for the reverse light it is possible for red, green and blue LED'S to be used simultaneously, whose colors will be complementary to each other and lead to white light. If white LED'S are available it will obviously be possible to use them as such. Furthermore, it is also possible to use other light emitting elements which have comparable properties and functions.

Illuminating devices with different colors of LED'S may be used also for illuminating articles in advertizing and in show business, in the entertainment industry and the like. A single beam producing device may thus be used to produce different light effects.

The LED'S may also be caused to flash in special applications. The low amperage required for LED'S means that very small energy storing devices may be used in applications in construction sites.

In place of homogeneously formed front sides, edges and back sides for beaming the light, it is also possible to have individual raised and recessed portions, whose configuration will respectively produce a collimating action, as for example in the form of a plurality of oblique faces or of reflector-like individual elements.

We claim:

1. An illuminating device, comprising: an essentially flat, transparent illuminating housing including a front

side, a rear surface and a circumferential side wall; a plurality of light emitting elements supported by said housing along said circumferential side wall; a reflecting layer provided in said housing on said rear surface thereof and along said circumferential sidewall; said reflective layer reflecting inwardly with respect to said housing; and, light collimating projection means including a front element in the form of one of a convex lens or an element with raised parts or recesses for projecting, and collimating light reflected by said reflecting layer and generated by said light emitting element.

2. An illuminating device according to claim 1, wherein said collimating projection means comprises a front convex lens element.

3. The illuminating device as claimed in claim 1, wherein the front side is provided with a reflecting layer in an edge part connected to said side wall, which has the light emitting elements.

4. The illuminating device as claimed in claim 1, wherein the reflecting layer is produced by sputtering, by the adhesive attachment of a film or by electroplating.

5. The illuminating device as claimed in claim 4, wherein the reflecting layer is connected with a cooling member adapted to take up heat therefrom.

6. The illuminating device as claimed in claim 1, wherein for producing desired light colors said light emitting elements comprise different LED'S are provided, in which respect more particularly for producing white light red, green and blue LED'S are provided.

7. The illuminating device as claimed in claim 6, wherein the LED'S with different colors are able to be selectively turned on so that LED'S in one color only or LED'S with different colors may be put into operation.

8. The illuminating device as claimed in claim 1, designed in the form of a motor vehicle headlamp or as a resin body in the form of an automobile taillight, more particularly as a combined structure with a brake light, a reverse light and/or a blinker.

9. The illuminating device as claimed in claim 1, designed in the form of a warning light for construction sites and the LED'S designed to flash while being operated with enhanced power.

10. A light projector for illuminating distant objects, comprising: a substantially flat transparent housing including a rear surface, circumferential side wall and a front lip; a light radiating surface provided on an interior side of said rear surface, circumferential side wall and said front lip for reflecting light inwardly from each of said rear surface, said circumferential side wall and said front lip; a plurality of light emitting diodes supported by said circumferential side wall and distributed substantially uniformly along said circumferential side wall, said lip extending outwardly from said side wall a distance which is greater than the distance said light emitting diodes extend from said circumferential side wall; light collimating means including a conical lens connected to said lip at a front side of said housing for focusing light, reflected by said light radiating surface, outwardly from said housing in a direction substantially perpendicular to said back wall.

* * * * *

US006215519B1

(12) **United States Patent**
Nayar et al.

(10) **Patent No.: US 6,215,519 B1**
(45) **Date of Patent: Apr. 10, 2001**

(54) **COMBINED WIDE ANGLE AND NARROW ANGLE IMAGING SYSTEM AND METHOD FOR SURVEILLANCE AND MONITORING**

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(73) Assignee: **The Trustees of Columbia University in the City of New York**, New York, NY (US)

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(22) Filed: **Mar. 4, 1998**

(51) Int. Cl.^{7} **H04N 7/18**; H04N 9/47

(52) U.S. Cl. **348/159**; 348/148

(58) **Field of Search** 348/143, 153, 348/154, 159, 169, 705, 148; H04N 7/18, 9/47

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Assistant Examiner—Nhon T Diep
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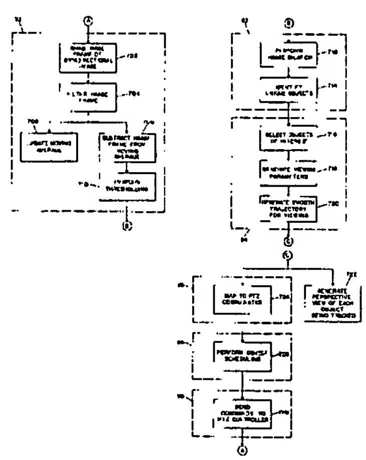
(57) **ABSTRACT**

A surveillance and monitoring system and method for monitoring an area which includes a first imaging system having a wide-angle field of view approximately equal to or greater than the area. The system also includes one or more second imaging systems having adjustable view settings, each of one or more second imaging systems being positioned to view portions of the area and being capable of producing images of the portions with a resolution greater than the first imaging system. The system also includes one or more controls for controlling the adjustable view settings of the one or more second imaging systems so as to obtain high-resolution, magnified images of regions of interest within the area being monitored. The adjustable view settings may include pan, tilt, and zoom settings for adjusting the panning, tilting, and zooming of one or more second imaging systems with respect to the monitored area. In the method, a global image of the area being monitored is sensed with a first imaging system having a field of view approximately equal to or greater than the area, a region of interest is detected within the global image, and one or more detailed images of the region of interest with at least one of one or more second imaging systems are sensed. At least one of the detailed images may have a higher resolution than that of the global image.

28 Claims, 13 Drawing Sheets

Microfiche Appendix Included
(1 Microfiche, 98 Pages)



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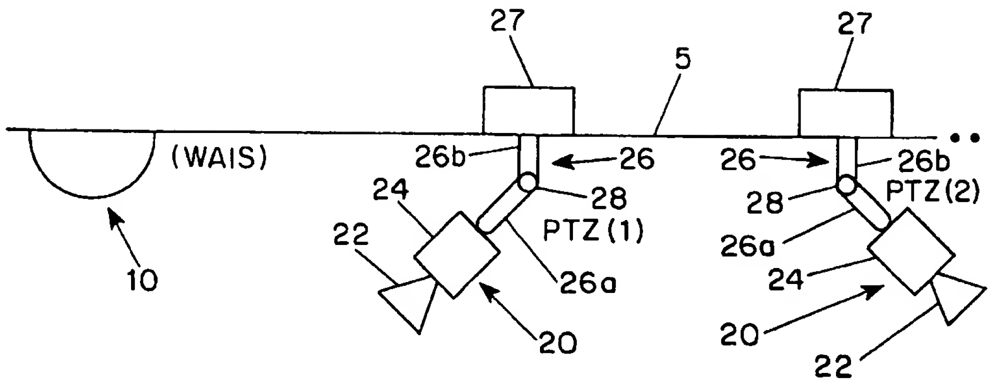
27
27
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(WAIS)
26b
26
26
26b
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PTZ(2)
22
PTZ(1)
26a
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26a
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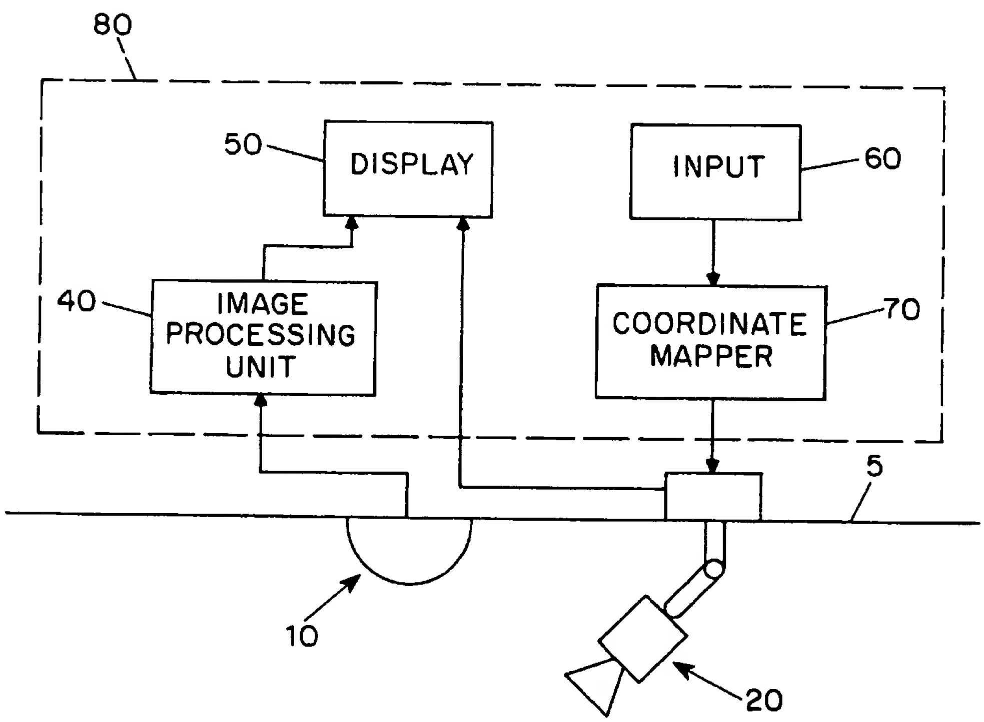
FIG. 1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DISPLAY
INPUT
60
40
IMAGE
PROCESSING
UNIT
COORDINATE
MAPPER
70
5
10
20

FIG. 2

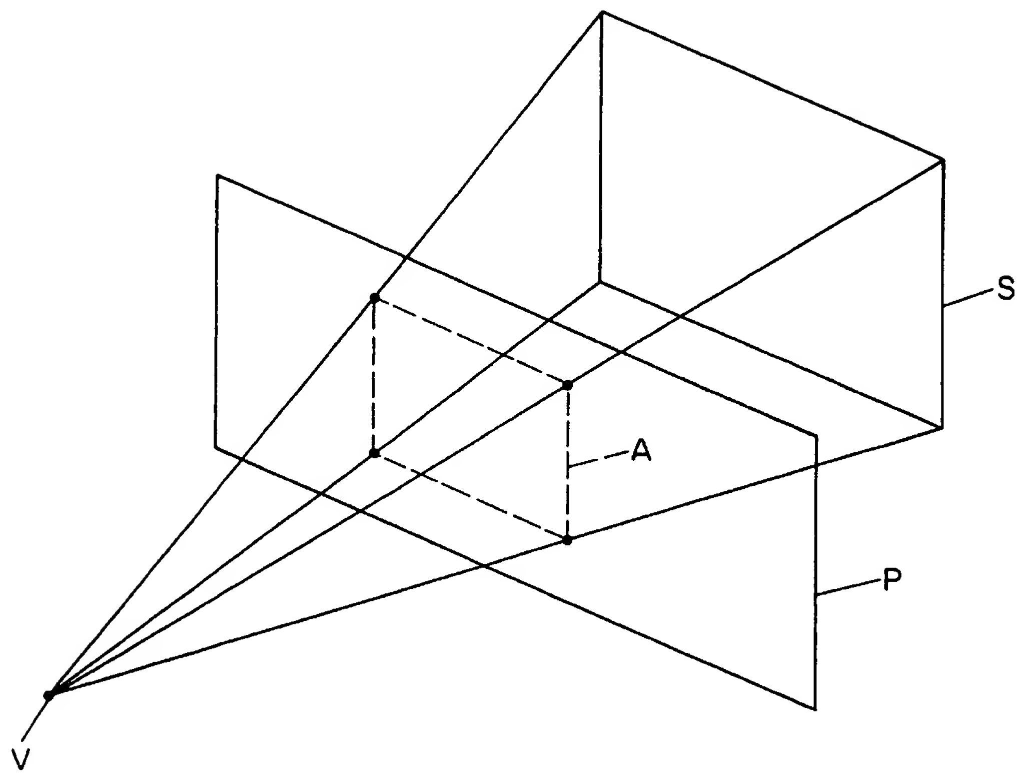

FIG. 3A

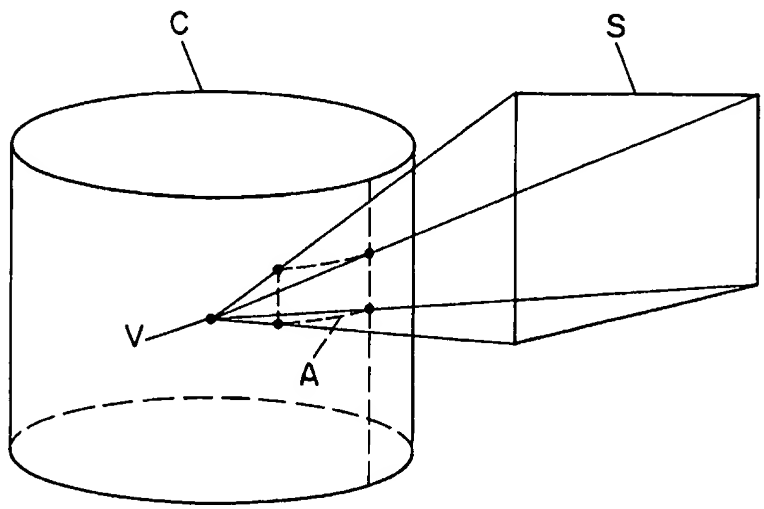

FIG. 3B

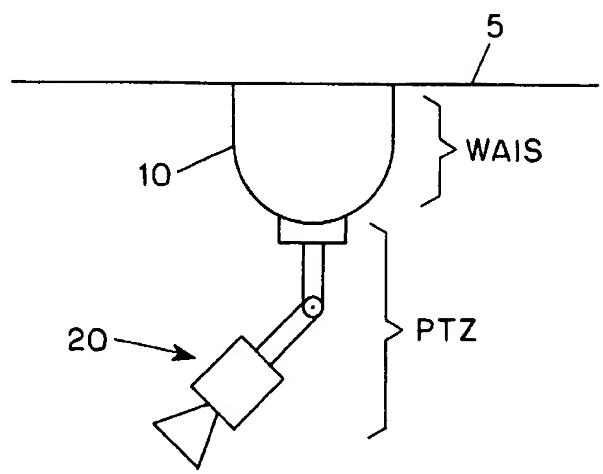

FIG. 4

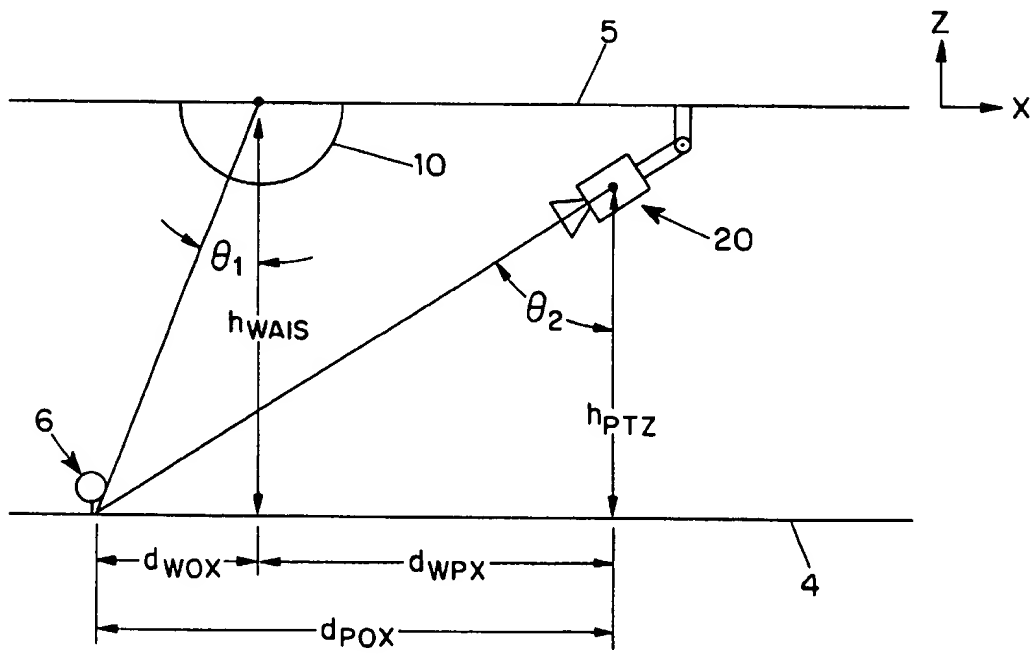

FIG. 5A

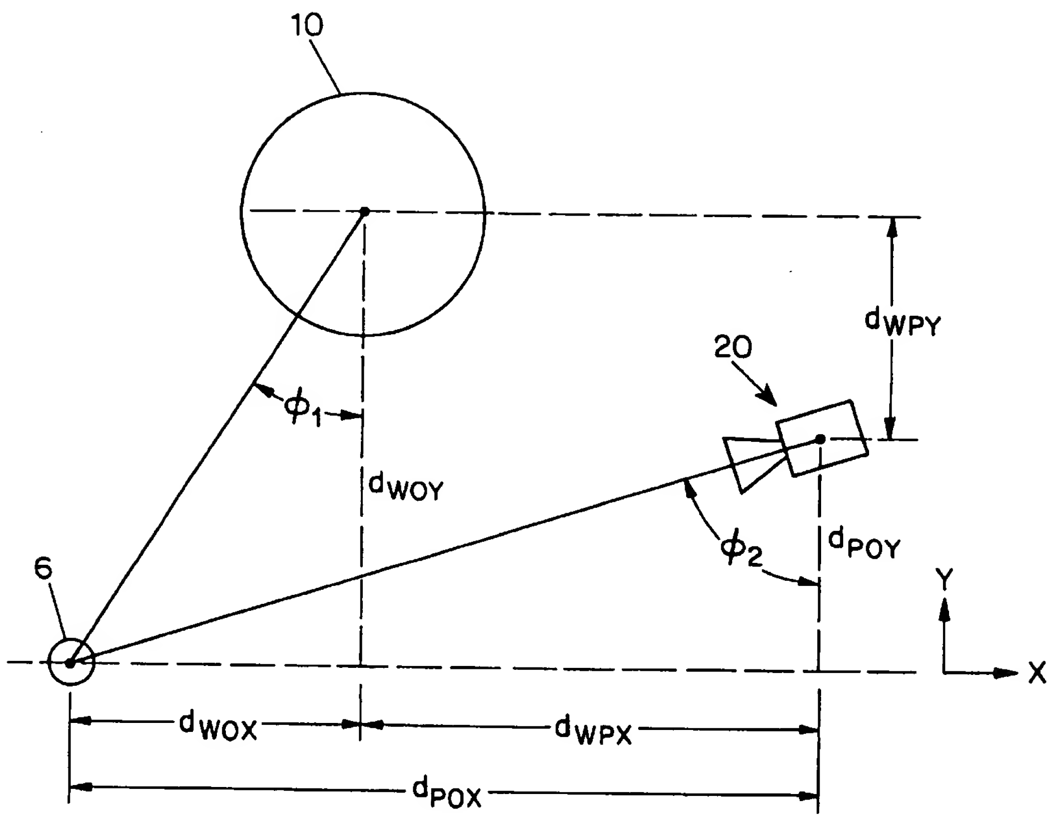

FIG. 5B

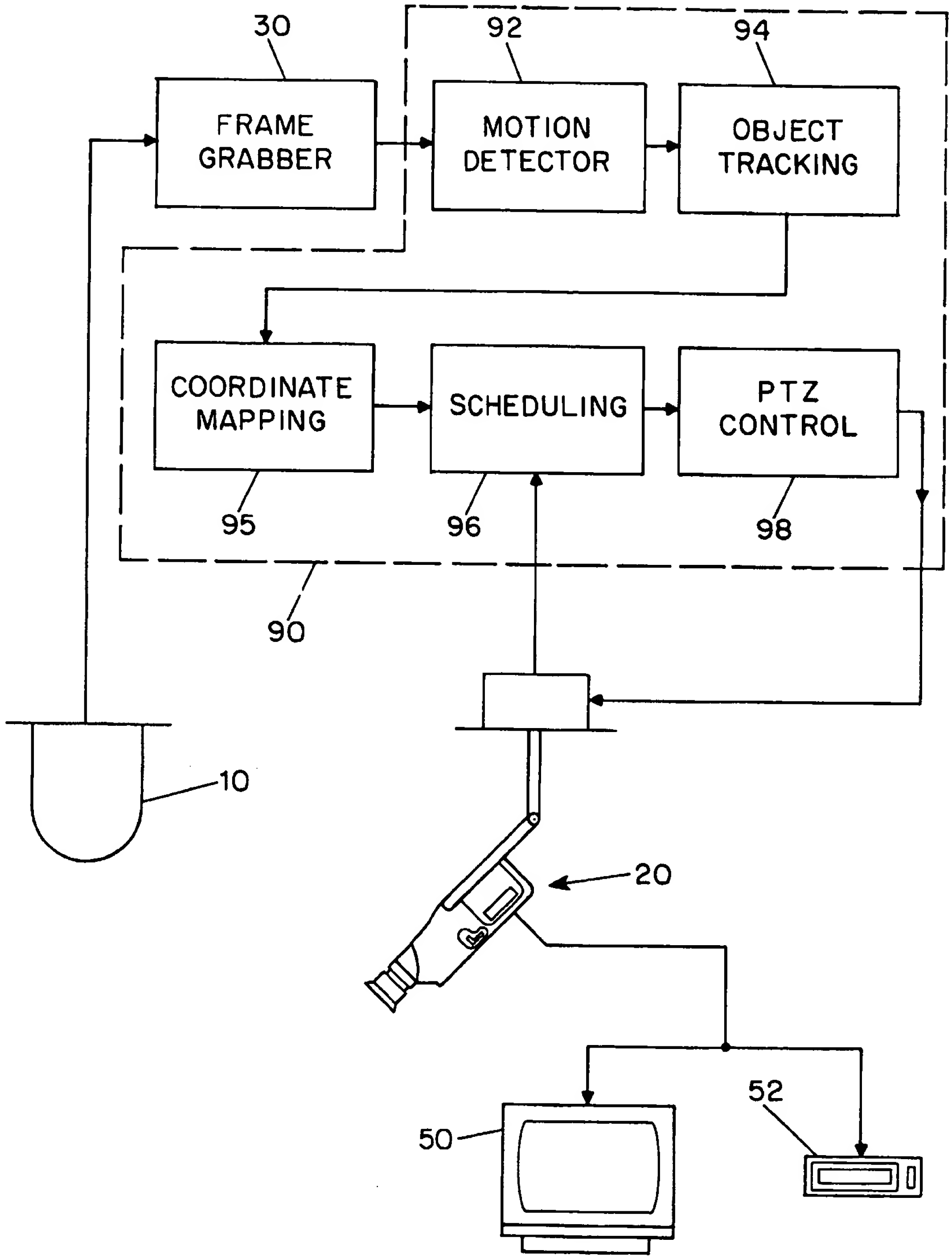
30
92
94
FRAME GRABBER
MOTION DETECTOR
OBJECT TRACKING
COORDINATE MAPPING
SCHEDULING
PTZ CONTROL
95
96
98
90
10
20
52
50

FIG. 6

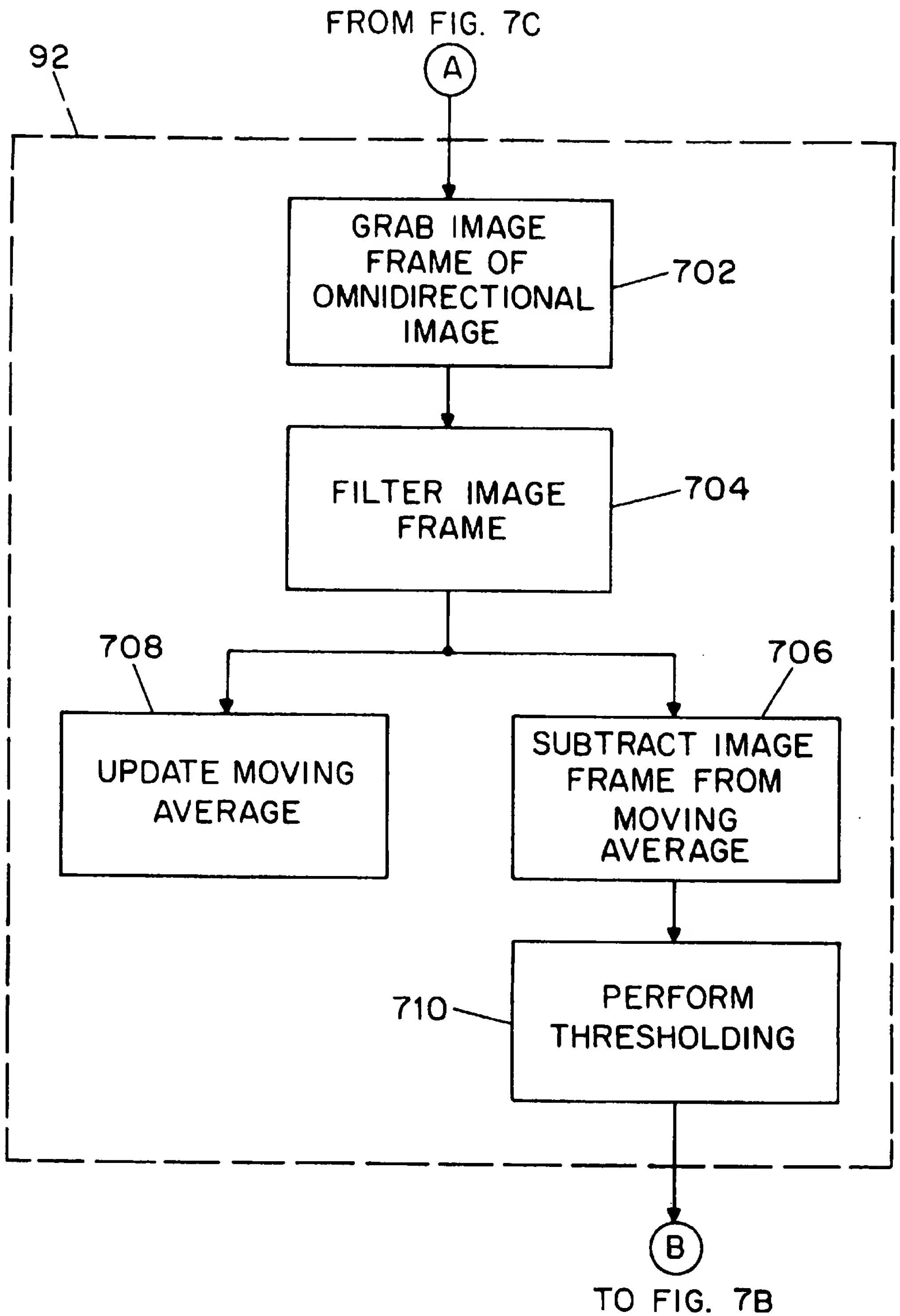
FROM FIG. 7C
A
92
GRAB IMAGE FRAME OF OMNIDIRECTIONAL IMAGE
702
FILTER IMAGE FRAME
704
708
706
UPDATE MOVING AVERAGE
SUBTRACT IMAGE FRAME FROM MOVING AVERAGE
710
PERFORM THRESHOLDING
B
TO FIG. 7B

FIG. 7A

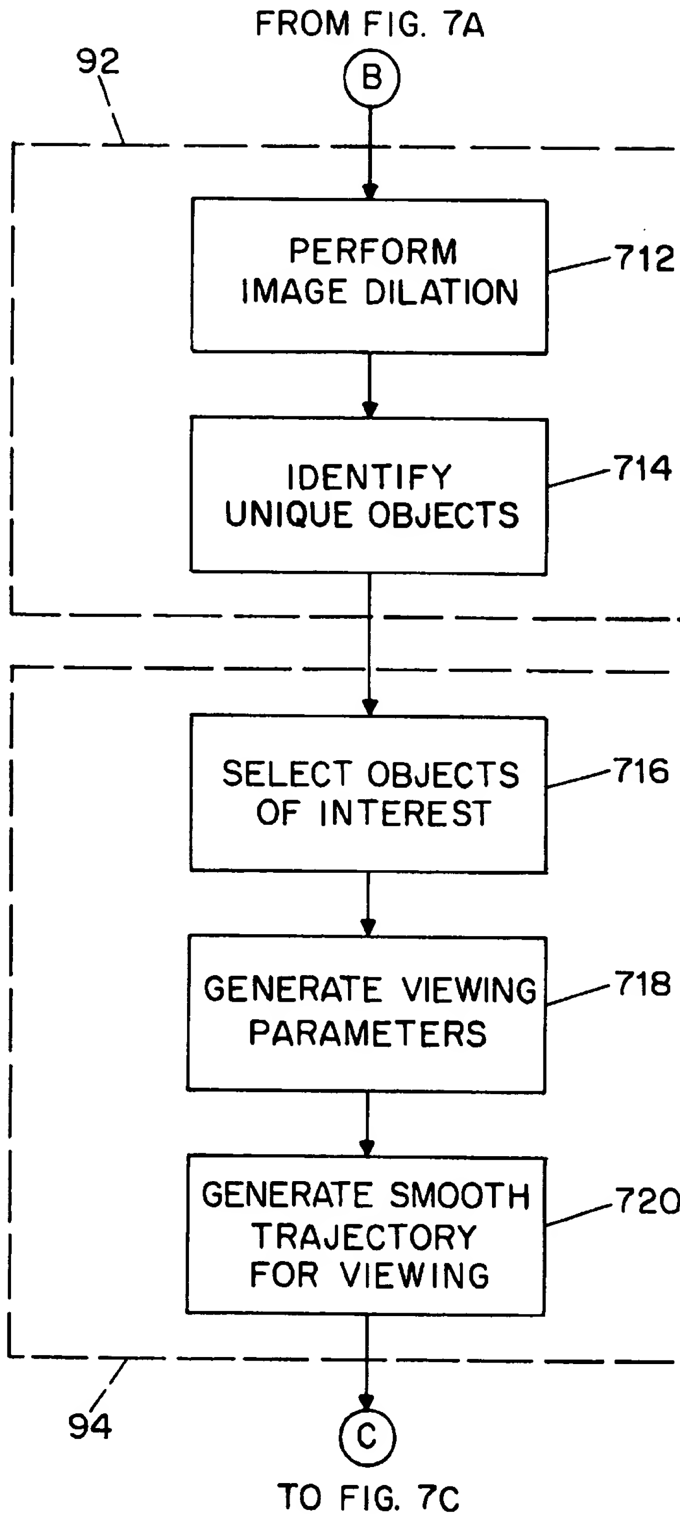
FROM FIG. 7A
B
92
PERFORM IMAGE DILATION
712
IDENTIFY UNIQUE OBJECTS
714
SELECT OBJECTS OF INTEREST
716
GENERATE VIEWING PARAMETERS
718
GENERATE SMOOTH TRAJECTORY FOR VIEWING
720
94
C
TO FIG. 7C

FIG. 7B

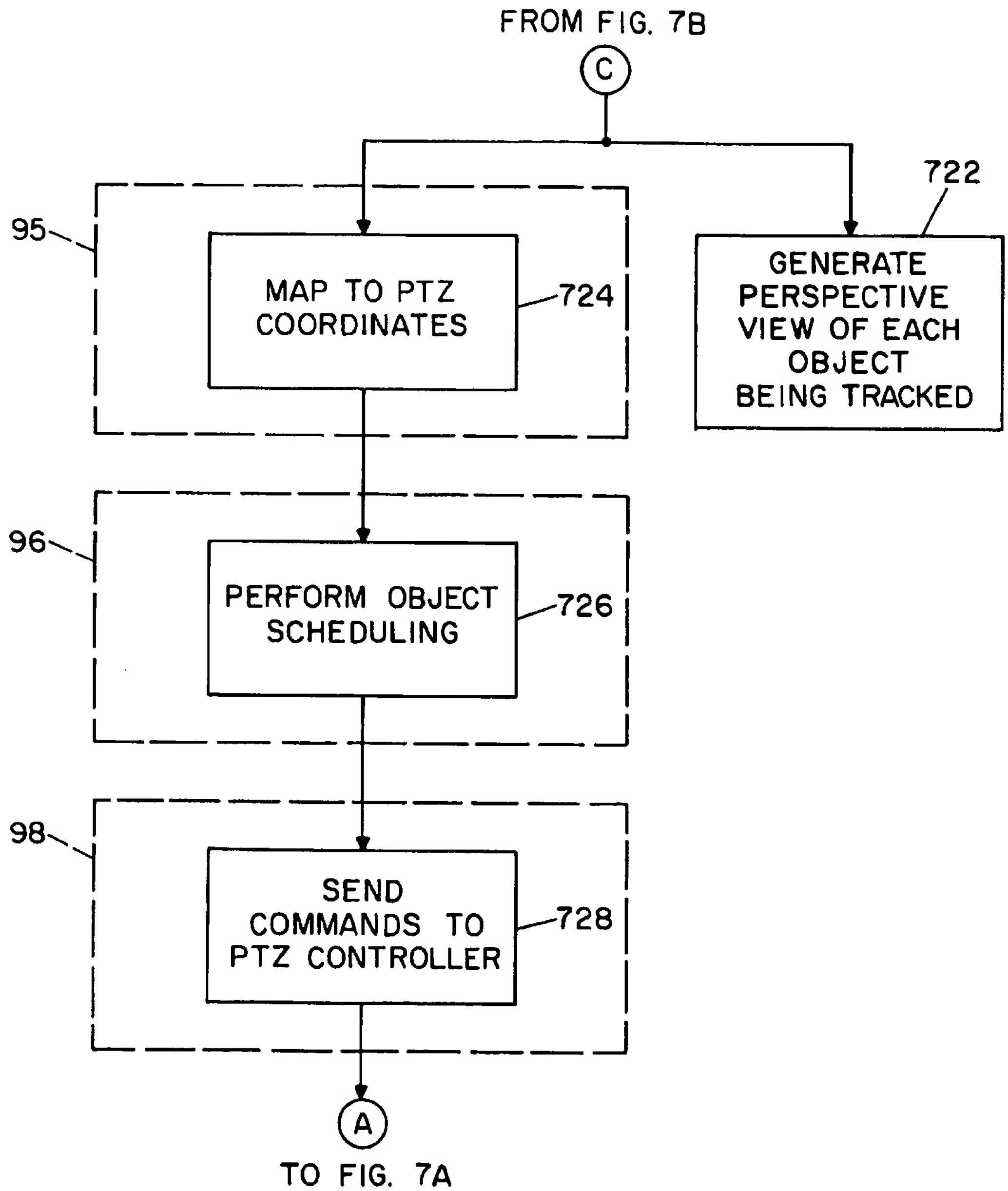
FROM FIG. 7B
C
95
MAP TO PTZ COORDINATES
724
722
GENERATE PERSPECTIVE VIEW OF EACH OBJECT BEING TRACKED
96
PERFORM OBJECT SCHEDULING
726
98
SEND COMMANDS TO PTZ CONTROLLER
728
A
TO FIG. 7A

FIG. 7C

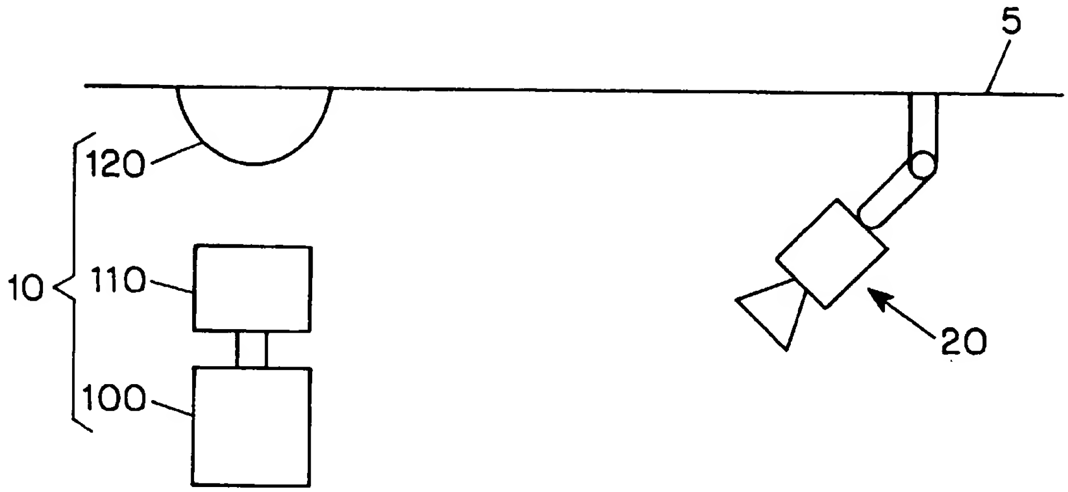

FIG. 8

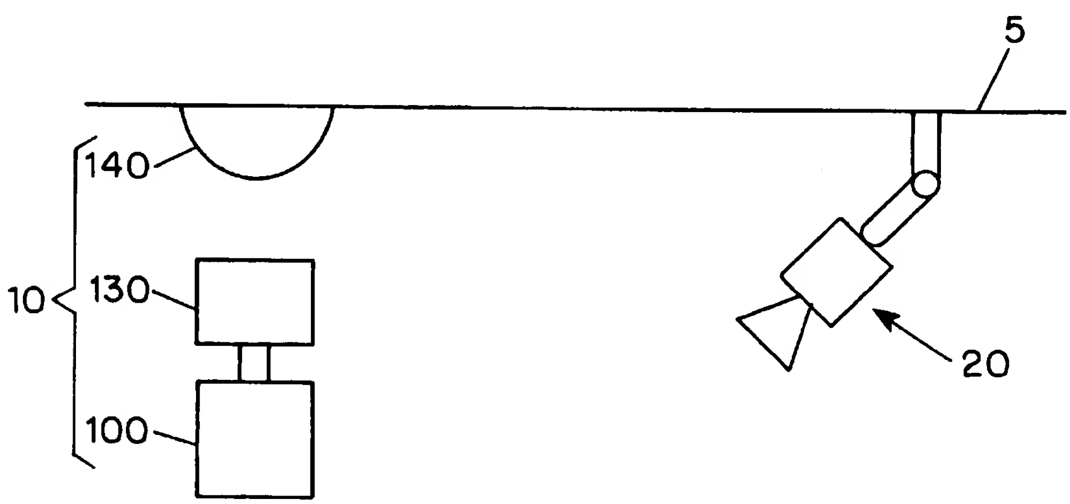

FIG. 9

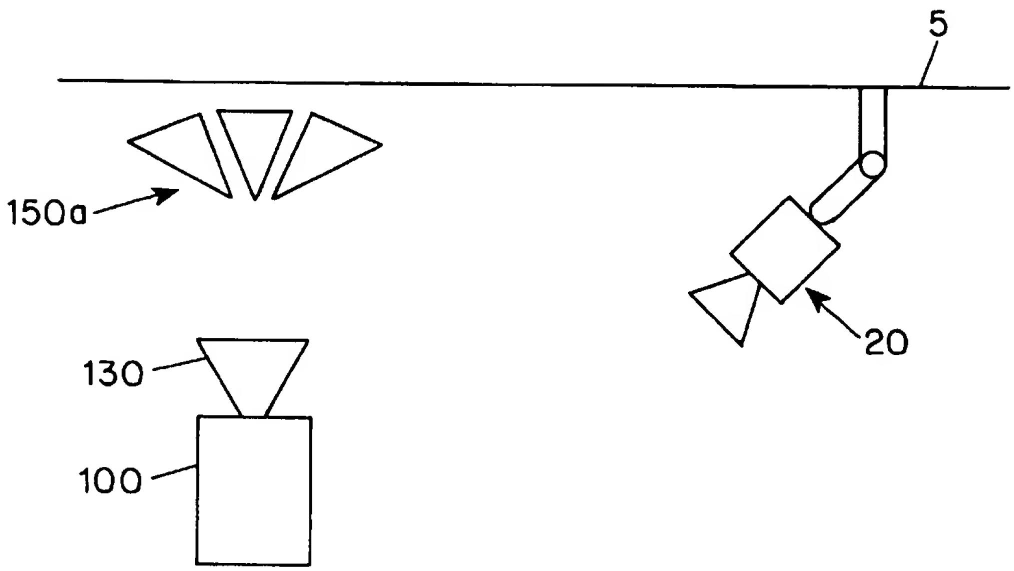

FIG. 10A

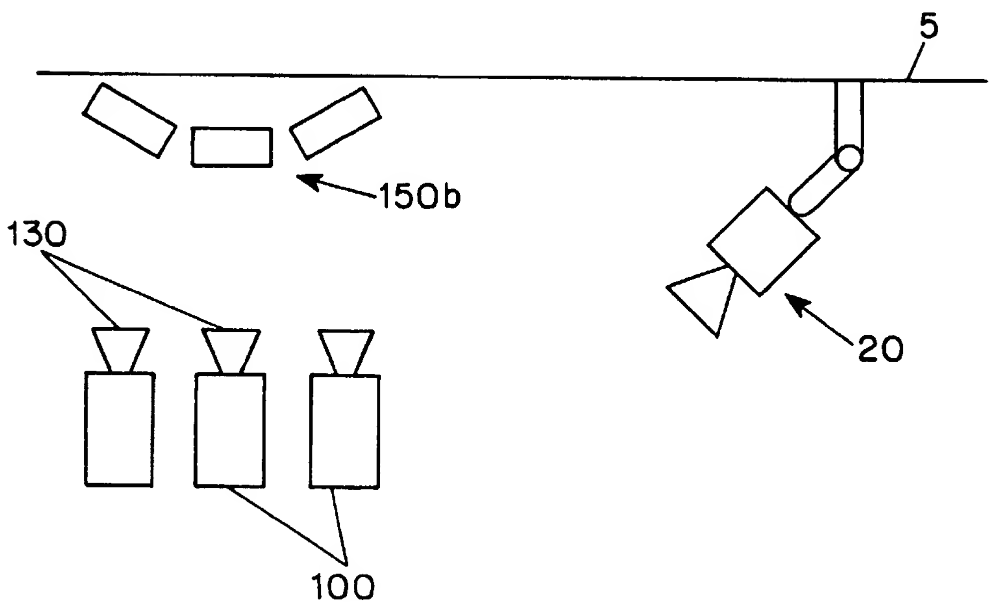

FIG. 10B

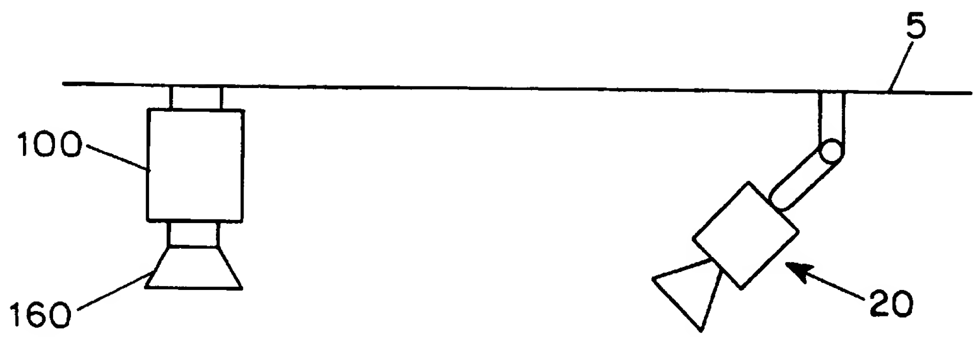

FIG. 11

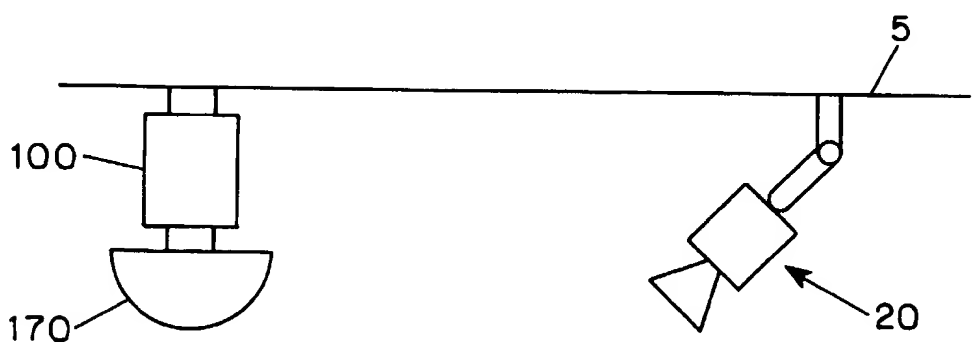

FIG. 12

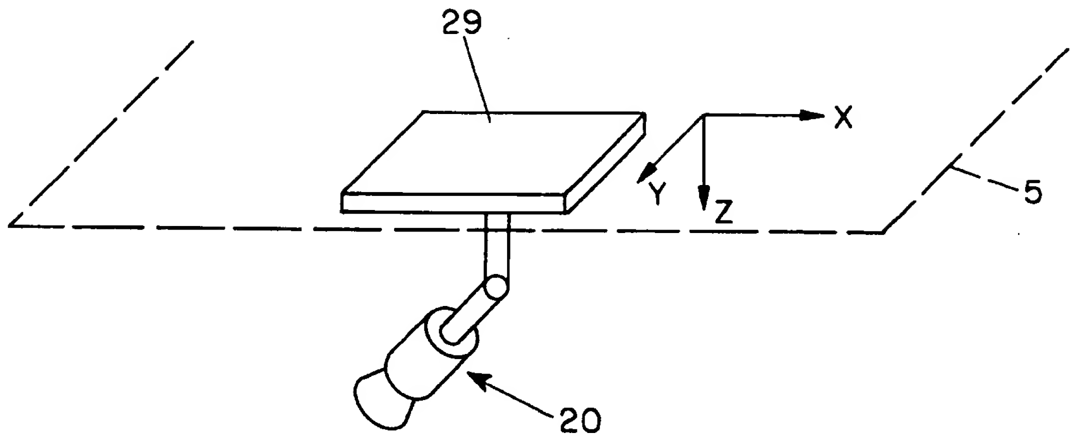

FIG. 13

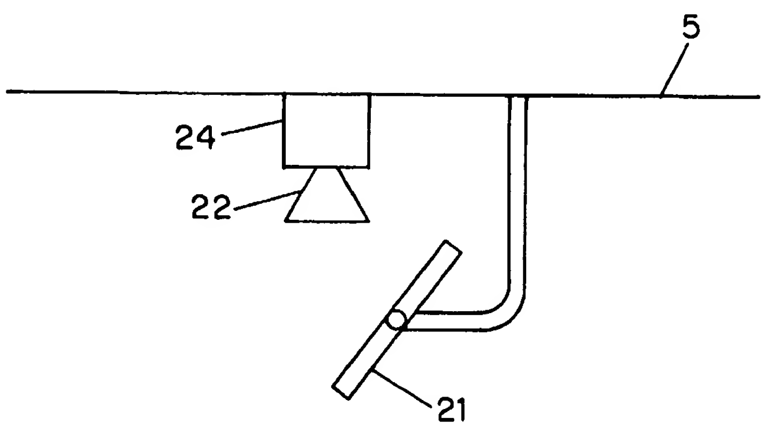

FIG. 14

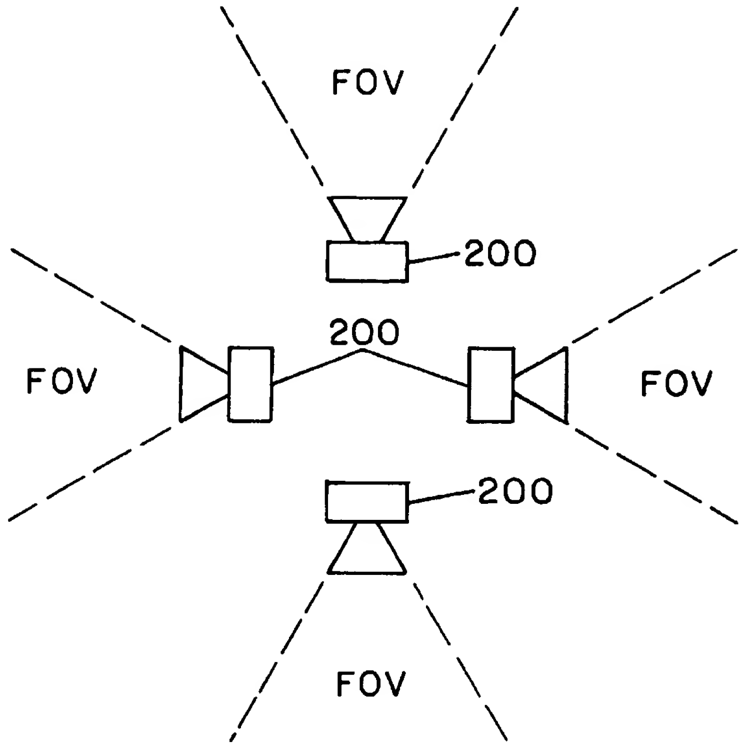

FIG. 15A

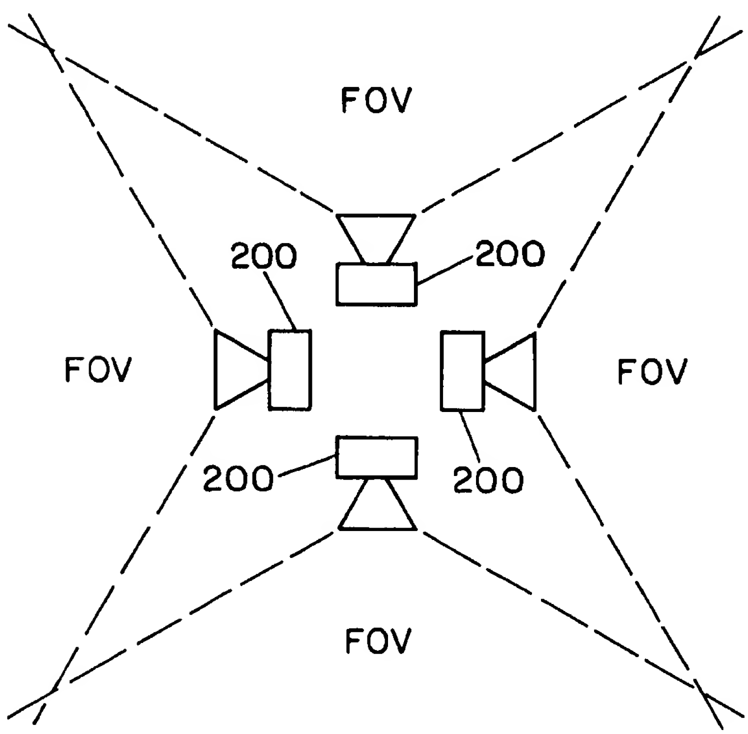

FIG. 15B

COMBINED WIDE ANGLE AND NARROW ANGLE IMAGING SYSTEM AND METHOD FOR SURVEILLANCE AND MONITORING

MICROFICHE APPENDIX

A microfiche appendix of a computer program for performing the techniques in accordance with the invention is attached to this document. There is a total of one microfiche having 98 frames as part of the appendix.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a system and method for monitoring and surveillance, and particularly to a system and method employing both wide-angle and narrow-angle imaging optics.

2. Discussion of the State of the Art

Traditionally, surveillance and monitoring ("SAM") systems have used off-the-shelf lenses and cameras for imaging. Because of the limitations of lenses, these systems typically provide very limited fields of view. To increase their limited fields of view, traditional SAM systems have relied on panning and tilting of the imaging system. As defined in this specification and the appended claims, "panning" refers to movement in a plane substantially horizontal to the area being monitored, and "tilting" refers to movement in a plane substantially vertical to the area being monitored. Typically, when a pan-and-tilt system is used, the system scans an area in some predefined or random path until an object of interest is detected. At that point, the object may be tracked by the system for further observation. Typically, such a system may also include a zoom lens for zooming in on objects of interest. Such systems are usually characterized as pan, tilt, and zoom ("PTZ") systems. Another approach to SAM systems has been the use of multiple PTZ systems to cover an area being monitored. Examples of PTZ systems are described in U.S. Pat. No. 5,627,616 to Sargeant et al.; U.S. Pat. No. 5,394,209 to Stiepel et al.; U.S. Pat. No. 5,164,827 to Paff; and U.S. Reissue Pat. No. 34,989 to Struhs et al., which are incorporated herein by reference.

While PTZ systems enlarge the field of view capable of being monitored by a lens-and-camera system, their scanning time makes them unsuitable for many real-time applications - - - i.e., fast-moving objects may enter and leave the area being monitored before the PTZ systems are able to detect them. Additionally, if a PTZ system uses a predefined scanning path, the monitoring performed by the system could be circumvented. That is, if an intruder is aware of the predefined scanning path, the intruder may be able to move about the monitored area without being detected by the PTZ system.

Another approach to SAM systems has been the use of wide-angle or so-called "omnidirectional" imaging systems. For example, the use of "fish-eye" lens for wide-angle viewing is disclosed in E. L. Hall et al., "Omnidirectional Viewing Using a Fish Eye Lens", SPIE Vol. 728 Optics, Illumination, and Image Sensing for Machine Vision (1986), p. 250, and U.S. Pat. No. 5,185,667 to Zimmerman, which is incorporated herein by reference. Since the fish-eye lens has a very short focal length, the field of view may be as large as or sometimes greater than a hemisphere.

Other prior art devices have used reflecting surfaces to increase the field of view. One such prior art device is disclosed in V.S. Nalwa, "A True Omni-Directional Viewer", AT&T Bell Laboratories Technical Memorandum, BL0115500-960115-01, January 1996. Nalwa discloses the use of multiple planar reflecting surfaces in conjunction with multiple charge-coupled device ("CCD") cameras to obtain a 360 degree panoramic image of a 50 degree band of a hemispherical scene. Specifically, in Nalwa, four planar mirrors are arranged in the shape of a pyramid, with one camera being positioned above each of the four planar reflecting sides, and with each camera viewing slightly more than 90 degrees by 50 degrees of the hemispherical scene. A similar device is disclosed in U.S. Pat. No. 5,539,483 to Nalwa, which is incorporated herein by reference.

Both Yagi et al., "Evaluating Effectivity of Map Generation by Tracking Vertical Edges in Omnidirectional Image Sequence", IEEE International Conference on Robotics and Automation, June 1995, p. 2334, and Yagi et al., "Map-Based Navigation for a Mobile Robot With Omnidirectional Image Sensor COPIS", IEEE Transactions on Robotics and Automation, Vol. II, No. 5, October 1995, disclose a conical projection image sensor (COPIS) which uses a conical reflecting surface to gather images from the surrounding environment and processes the information to guide the navigation of a mobile robot.

Yamazawa et al., "Obstacle Detection With Omnidirectional Image Sensor HyperOmni Vision", IEEE International Conference on Robotics and Automation, October 1995, p. 1062, discloses a purported improvement to the COPIS system which involves the use of a hyperboloidal reflecting surface in place of a conical surface. Prior to Yamazawa et al., U.S. Pat. No. 3,505,465 to Donald Rees also disclosed the use of a hyperboloidal reflecting surface to achieve panoramic viewing. Rees is incorporated herein by reference.

As compared to traditional PTZ systems, the wide-angle or omnidirectional prior art devices described above have certain disadvantages. For example, the wide-angle or omnidirectional devices typically provide image resolution that is relatively low as compared to traditional PTZ systems. This is because, to avoid costly special designs, the wide-angle or omnidirectional devices typically utilize off-the-shelf cameras whose resolution is adequate for smaller fields of view. In addition, a lower resolution is often necessary if real-time video images are desired from the wide-angle or omnidirectional devices because real-time, high resolution video images of a wide field of view require a great amount of throughput on the part of image processing equipment connected to the wide-angle or omnidirectional devices. Moreover, a further drawback of wide-angle or omnidirectional devices as compared to traditional PTZ systems is that zooming in on a region of interest by image processing of a wide-angle or omnidirectional image cannot provide better resolution of the region of interest than in the original wide-angle or omnidirectional image, whereas zooming in on a region of interest with a zoom lens of a traditional PTZ system can provide higher resolution of the region of interest than in the original image.

Accordingly, there exists a need for a cost-effective SAM system that provides both a wide-angle field of view of an area being monitored in combination with the capability for high-resolution images of regions of interest within the monitored area.

SUMMARY OF THE INVENTION

The primary objective of the present invention is to provide a surveillance and monitoring system and method that provides both a wide-angle field of view of an area being monitored as well as the capability for high-

resolution, magnified images of regions of interest within the monitored area. Other objectives will become apparent to those skilled in the art as they read the specification herein.

To overcome the drawbacks of the prior art, a surveillance and monitoring system according to the present invention includes a first imaging system having a wide-angle field of view approximately equal to or greater than the area being monitored. The system also includes one or more second imaging systems having adjustable view settings, each of the second imaging systems positioned to view portions of the area and being capable of producing images of the portions with a greater resolution than the first imaging system. The system also includes one or more controls for controlling the adjustable view settings of the one or more second imaging systems.

In use, the first imaging system provides a wide-angle view of the area being monitored. The wide angle view is then used to control the adjustable view settings of the second imaging systems, which are capable of providing greater resolution images of regions of interest within the area.

In a preferred embodiment of the surveillance and monitoring system of the present invention, the adjustable view settings include pan, tilt, and zoom settings for adjusting the panning, tilting, and zooming of the one or more second imaging systems with respect to the area being monitored.

In another preferred embodiment of the surveillance and monitoring system of the present invention, the area is substantially hemispherical and the first imaging system has a substantially hemispherical field of view.

In another preferred embodiment of the surveillance and monitoring system of the present invention, the first imaging system is a catadioptric system, which includes a reflecting surface positioned to reflect an image of the area being monitored and one or more image sensors optically coupled to the reflecting surface. Most preferably, the reflecting surface of the catadioptric system is a truncated, substantially paraboloid-shaped mirror. Alternatively, the reflecting surface of the catadioptric system may include a substantially hyperboloidal-shaped mirror, a substantially ellipsoidal-shaped mirror, one or more curved mirrors, or one or more planar mirrors.

Instead of catadioptric systems, the first imaging system may include wide-angle imaging optics coupled to one or more image sensors. Such optics may include a wide-angle lens or a fish-eye lens. In addition, the first imaging system may include a plurality of camera systems.

In yet another preferred embodiment of the present invention, a monitoring station is provided, which includes one or more displays, at least one display coupled to the first imaging system for displaying an image of the area being monitored and at least one display coupled to the one or more second imaging systems for displaying a region of interest within the area. The monitoring station includes input means for selecting the region of interest from the display coupled to the first imaging system. The input means is operatively coupled to the controls for controlling the adjustable view settings, such that at least one of the second imaging systems is positioned to view the region of interest.

In yet another preferred embodiment of the present invention, the first imaging system provides an image signal representative of the area being monitored, and the surveillance and monitoring system further includes an image signal processing apparatus coupled to the first imaging system to convert the image signal into image signal data.

Preferably, the image signal processing apparatus includes means for mapping the image signal data into a Cartesian-coordinate system to produce a perspective image or into a cylindrical-coordinate system to produce a panoramic image.

In yet another preferred embodiment, the surveillance and monitoring system of the present invention further includes motion detection means coupled to the first imaging system for detecting objects in motion in the area being monitored. Preferably, the motion detection means is coupled to a tracking means for tracking one or more of the objects in motion. The tracking means may then be coupled to the controls for the adjustable view settings of the second imaging systems to view the objects being tracked with the second imaging systems.

In yet another preferred embodiment of the present invention, a surveillance and monitoring system for monitoring an area is provided comprising: a wide-angle imaging system having a wide-angle field of view approximately equal to or greater than the area; motion detection means coupled to the imaging system for detecting objects in motion in the area; tracking means coupled to the motion detection means for tracking one or more of the detected objects in motion; and image processing means coupled to the tracking means and the wide-angle imaging system for producing perspective images of the tracked objects from images provided by the wide-angle imaging system.

In accordance with the present invention, a method is also provided for monitoring an area. The method includes the steps of: sensing a global image of the area being monitored with a first imaging system having a field of view approximately equal to or greater than the area; detecting a region of interest within the global image; and sensing one or more detailed images of the region of interest with at least one of the one or more second imaging systems, at least one of the detailed images having a higher resolution than the global image.

In another preferred embodiment of the present invention, a method is provided which includes the steps of: positioning a first imaging system to view the area, the first imaging system having a wide-angle field of view approximately equal to or greater than the area; positioning one or more second imaging systems having adjustable view settings to view portions of the area, each of the one or more second imaging systems being capable of producing images of the portions with a resolution greater than the first imaging system; sensing an image of the area with the first imaging system; detecting a region of interest within the sensed image; and controlling the adjustable view settings so as to view the region of interest with at least one of the one or more second imaging systems.

In accordance with the present invention, a method for monitoring one or more objects in motion in an area is also provided, which includes the steps of: positioning a first imaging system to view the area, the first imaging system having a wide-angle field of view approximately equal to or greater than the area; positioning one or more second imaging systems having adjustable view settings to view portions of the area, each of the one or more second imaging systems being capable of producing images of the portions with a resolution greater than the first imaging system; sensing images of the area with the first imaging system; detecting the one or more objects in motion from the sensed images; tracking one or more of the detected objects; and controlling the adjustable view settings so as to view the tracked objects with at least one of the one or more second imaging systems.

Preferably, the step of detecting in the method for monitoring one or more objects in motion includes the sub-steps of: generating a series of image frames at predetermined time intervals from the sensed images; filtering the series of image frames for noise; calculating a moving average frame from a subset of the series of image frames comprising the set from the first image frame to the next-to-last image frame; subtracting the filtered, last image frame of the series of image frames from the moving average frame to produce a difference image frame; comparing each pixel of the difference image frame to a predetermined threshold value to produce a threshold image frame indicative of regions of motion in the area; defining a first group of objects associated with the subset of the series of image frames; associating a second group of objects with the regions of motion in the threshold image frame; and generating a third group of objects comprising all unique objects in the first and second groups.

In a preferred embodiment, the tracking step in the method for monitoring one or more objects in motion includes the sub-steps of: selecting a fourth group of objects to be tracked from the third group of objects on the basis of a predetermined criteria; determining a focus point for each object in the fourth group of objects; and applying a smoothing function to the focus point of each object.

Further, a preferred embodiment of the controlling step in the method for monitoring one or more objects in motion includes mapping the coordinates of the objects being tracked from the coordinate system of the first imaging system into the coordinate system of at least one of the second imaging systems.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the present invention will now be described in detail with reference in the accompanying drawings in which:

FIG. 1 is a side view of a video surveillance and monitoring system according to a preferred embodiment of the present invention;

FIG. 2 is a functional block diagram of a video surveillance and monitoring system according to another preferred embodiment of the present invention;

FIG. 3A provides an illustration of perspective mapping;

FIG. 3B provides an illustration of cylindrical mapping;

FIG. 4 is a side view of a video surveillance and monitoring system according to another preferred embodiment of the present invention, in which the pan, tilt, and zoom camera is positioned directly underneath the wide-angle imaging system;

FIGS. 5A and 5B illustrate the mapping of object coordinates from the coordinate system of a wide-angle imaging system to the coordinate system of a pan, tilt, and zoom imaging system;

FIG. 6 is a functional block diagram of a video surveillance and monitoring system according to another preferred embodiment of the present invention;

FIGS. 7A to 7C provide a flowchart of a preferred embodiment of a method for monitoring one or more objects in motion in an area;

FIG. 8 is a side view of a video surveillance and monitoring system according to another preferred embodiment of the present invention, in which the wide-angle imaging system includes a catadioptric system with a paraboloid-shaped mirror;

FIG. 9 is a side view of a video surveillance and monitoring system according to another preferred embodiment of the present invention, in which the wide-angle imaging system includes a catadioptric system with a hyperboloidal-shaped mirror;

FIG. 10A is a side view of a video surveillance and monitoring system according to another preferred embodiment of the present invention, in which the wide-angle imaging system includes a catadioptric system with a plurality of planar mirrors arranged in a pyramid shape;

FIG. 10B is a side view of a video surveillance and monitoring system according to another preferred embodiment of the present invention, in which the wide-angle imaging system includes a catadioptric system with a plurality of planar mirrors arranged in a polyhedral-shape;

FIG. 11 is a side view of a video surveillance and monitoring system according to another preferred embodiment of the present invention, in which the wide-angle imaging system includes a wide-angle lens;

FIG. 12 is a side view of a video surveillance and monitoring system according to another preferred embodiment of the present invention, in which the wide-angle imaging system includes a fish-eye lens;

FIG. 13 is a perspective view of a video surveillance and monitoring system according to another preferred embodiment of the present invention, in which the pan, tilt, and zoom camera is mounted on a movable base;

FIG. 14 is a side view of a video surveillance and monitoring system according to another preferred embodiment of the present invention, in which the pan, tilt, and zoom camera contains a fixed camera and fixed optics and a movable mirror positioned between the camera and optics and the area to be monitored; and

FIGS. 15A and 15B are top plan views of video surveillance and monitoring systems according to preferred embodiments of the present invention, in which the wide-angle imaging system includes a plurality of camera systems.

DETAILED DESCRIPTION

FIG. 1 shows a preferred embodiment of the present invention. Arranged along a ceiling **5** is a wide-angle imaging system ("WAIS") **10**, which has a field of view approximately equal to or greater than the area being monitored. Also arranged along the ceiling **5** are one or more pan, tilt, and zoom ("PTZ") imaging systems **20**. FIG. **1** shows, for example, two such imaging systems arranged along the ceiling **5**. Each PTZ system **20** has a field of view smaller than that of the WAIS **10**, but has a resolution that is relatively greater. As illustrated in FIG. **1**, each PTZ system **20** includes optics **22**, a camera **24** for sensing the images provided by the optics **22**, a pivot arm **26** for movement of the camera **24** and optics **22**, and a PTZ controller **27** mounted to the ceiling **5** for controlling the movement of the pivot arm **26**. The pivot arm **26** is divided into two segments, a lower segment **26***a* connected to the camera **24** and an upper segment **26***b* pivotably mounted to the PTZ controller **27**. The two segments **26***a* and **26***b* are joined by a pivot **28**. In this embodiment, the pivot arm **26** provides each PTZ system **20** with a two-degree freedom of movement. Specifically, the pivotal connection of the upper segment **26***b* with the PTZ controller **27** provides each PTZ system **20** with the ability to pan around an axis perpendicular to the ceiling **5**, and the pivot **28** between the and lower and upper segments **26***a* and **26***b* provides each PTZ system **20** with the ability to tilt with respect to the plane of the ceiling **5**. Preferably, the optics **22** includes a zoom lens, which allows magnification of a region of interest within a PTZ system's field of view.

In use, the WAIS 10 of the present invention provides a global view of the area being monitored. When a region of interest within the monitored area is detected in the global view provided by the WAIS 10, one or more of the PTZ systems 20 are moved to view the region of interest and are used to obtain high-resolution, magnified images of that region.

Although each PTZ system 20 of the preferred embodiment just described includes a pivot arm 26 providing a two-degree freedom of movement for each system, the presently claimed invention is, of course, not limited to such an embodiment. For example, a third degree of freedom could also be added to each PTZ system 20 by adding a means for rolling or rotating the camera 24 and optics 22 around the optical axis. In addition, the camera may have focus and iris settings. As shown in FIG. 13, a PTZ system 20 could also include a movable base 29, which provides translational movement in three perpendicular axes x, y, and z. This movable base 29 provides another three degrees of freedom of movement to each PTZ system 20. Moreover, as shown in FIG. 14, instead of moving the camera and optics of a PTZ system 20, the PTZ system 20 could have a fixed camera 24 and fixed optics 22 and a movable mirror 21 positioned between them and the area to be monitored. In this embodiment, the movable mirror 21 provides the panning and tilting capability for each PTZ system 20.

FIG. 2 provides a functional block diagram of a surveillance and monitoring system according to another preferred embodiment of the present invention. In the embodiment of FIG. 2, a WAIS 10 is used in combination with a single PTZ system 20. The WAIS 10 provides images to a display 50, preferably through an image processing unit 40. The display 50 is part of a monitoring station 80, which is attended to by an operator. The operator stationed at the monitoring station 80 observes the images provided by the WAIS 10, and when the operator detects a region of interest within the area being monitored and desires to get a better view of the region, the operator selects the region using input means 60. Input means 60 may include any well-know type of input device, such as a keyboard, a mouse, a joystick, or a touch-sensitive panel. The input means 60 communicates the input data provided by the operator to a coordinate mapping unit 70. Using the input data, the coordinate mapping unit 70 provides the appropriate pan, tilt, and zoom settings to the PTZ system 20, so that the PTZ system 20 is directed to view the region of interest. The PTZ system 20 subsequently provides high-resolution, zoomed images of the region of interest to the display 50.

While it is possible to display the raw image output from the WAIS 10 on the display 50, preferably, as shown in FIG. 2, the images from the WAIS 10 are processed through an image processing unit 40 before they are displayed on the display 50. The image processing unit 40 maps the image data from the WAIS 10 into either a Cartesian-coordinate system to produce a perspective image or into a cylindrical-coordinate system to produce a panoramic image. Such mapping makes it easier for a human operator to interpret the image being displayed and, hence, to select a region of interest.

The details of the perspective and panoramic mapping will depend on the exact type of WAIS 10 used, but the general principles are well known in the art and are described, for example, in S. E. Chen, "Quicktime VR—An Image-Based Approach to Virtual Environment Navigation", Proc. of SIGGRAPH 95, (8):29–38, August 1995. The general principles are also briefly illustrated in FIGS. 3A and 3B. FIG. 3A illustrates a perspective mapping of a scene S from a viewpoint V. The perspective mapping is the projection A onto a plane P, the projection A consisting of the points of intersection of plane P with rays from scene S passing through the viewpoint V. FIG. 3B illustrates a panoramic mapping of a scene S from a viewpoint V. The panoramic mapping is the projection A of the scene S onto a cylinder C surrounding the viewpoint V. The projection A consists of the points of intersection of the cylinder C with the rays from scene S passing through the viewpoint V. Advantageously, by mapping onto a cylinder, a complete 360 degree view of the scene may be obtained. The cylindrical projection may then be further mapped onto a plane for a panoramic display on a flat screen. The cylinder-to-plane mapping may be visualized by cutting the cylinder in FIG. 3B length-wise and flattening it out.

To provide appropriate pan, tilt, and zoom settings to the PTZ system 20, the coordinate mapping unit 70 must map the coordinates of a region or object of interest in the WAIS 10 to the corresponding coordinates in the PTZ system 20. To avoid or simplify such mapping, it is preferred that PTZ system 20 should be placed very close to the WAIS 10. The close proximity of the PTZ system 20 and the WAIS 10 ensures that the viewing directions of both systems are about the same. Therefore, mapping of object coordinates from the WAIS 10 to the PTZ system 20 involves little, or no, computation. FIG. 4 shows an especially preferred embodiment of an arrangement of a WAIS 10 and a PTZ system 20, in which the PTZ system 20 is placed directly underneath the WAIS 10.

In practice, of course, it may be necessary to have one or more PTZ systems distributed around, instead of in close proximity to, a WAIS. In that case, to translate object coordinates between systems, assumptions must be made about the distance of objects from the WAIS 10 and the PTZ systems 20, given the geometry of the area being monitored. For example, assuming the area being monitored contains a flat, level floor, an assumption can be made that the objects of interest will be at or near the known floor level of the area being monitored (as in the case of humans walking about the area).

FIGS. 5A and 5B illustrate the relationships between the coordinate systems of a WAIS 10 and a PTZ system 20 when the PTZ system 20 is not located near the WAIS 10. In the figures, an object 6 is observed in the WAIS 10 having coordinates (θ_1,ϕ_1) and corresponding coordinates in the PTZ system 20 of (θ_2, ϕ_2). The angles θ_1 and θ_2 define the coordinate angle of the object in the x-z plane, which is perpendicular to the ceiling and floor, and the angles ϕ_1 and ϕ_2 define the coordinate angle of the object in the x-y plane, which is parallel to the ceiling and floor. An assumption is made that the object 6 is located at floor level (or at a fixed height from the floor level), which is a known perpendicular distance h_{wais} from the WAIS 10 and a known perpendicular distance h_{ptz} from the PTZ system 20. Using this assumption, the distance between the WAIS 10 and the object 6 along the x-axis, d_{wax}, can be derived as shown in equation (1).

$$d_{wax}=h_{wais} \tan \theta_1 \tag{1}$$

Similarly, the distance between the PTZ system 20 and the object 6 along the x-axis, d_{pax}, can be derived as shown in equation (2).

$$d_{pax}=h_{ptz} \tan \theta_2 \tag{2}$$

Using the relationship of equation (3),

$$d_{pox}=d_{wox}+d_{wpx} \quad (3)$$

where d_{wpx} is the known distance along the x-axis of the WAIS 10 from the PTZ system 20, angle θ_2 can be derived by those of ordinary skill in the art as shown in equation (4).

$$\tan\theta_2 = \frac{h_{wois}\tan\theta_1 + d_{wpx}}{h_{ptz}} \quad (4)$$

In a similar manner, the angle ϕ_2 can be derived as shown in equations (5), (6), and (7).

$$d_{poy}=d_{woy}-d_{wpy} \quad (6$$

$$d_{woy} = \frac{d_{wox}}{\tan\phi_1} = \frac{h_{wois}\tan\theta_1}{\tan\phi_1} \quad (5)$$

$$d_{poy} = d_{woy} - d_{wpy} \quad (6)$$

$$\tan\phi_2 = \frac{d_{wox}+d_{wpx}}{d_{poy}} = \frac{d_{wox}+d_{wpx}}{d_{woy}-d_{wpy}} = \frac{h_{wois}\tan\theta_1\tan\phi_1 + d_{wpx}\tan\phi_1}{h_{wois}\tan\theta_1 - d_{wpy}\tan\phi_1} \quad (7)$$

In equations (6) and (7), d_{wpy} is the known distance between the WAIS 10 and the PTZ system 20 along the y-axis. Using equations (4) and (7), therefore, the PTZ mapping unit 70 may map object coordinates from the coordinate system of the WAIS 10 to that of the PTZ system 20.

FIG. 6 provides a functional block diagram of a surveillance and monitoring system according to another preferred embodiment of the present invention. In this embodiment, the WAIS 10 provides image data to a frame grabber 30, which captures image frames from the WAIS 10 at predetermined intervals. The frame grabber 30 provides the image frames to a motion detection unit 92, which algorithmically detects the movement of objects within a series of image frames. The motion detection unit 92 communicates with an object tracking unit 94, which tracks the detected objects. The object tracking unit 94 communicates with a coordinate mapping unit 95, which maps the coordinates of objects from the coordinate system of the WAIS 10 to that of the PTZ system 20, as discussed previously.

When a single PTZ system is used to track multiple objects, as in the embodiment of FIG. 6, the PTZ system 20 must be time-shared among the objects being tracked. Accordingly, it is preferred that a PTZ scheduling unit 96 is included, which prioritizes the objects being tracked by the object tracking unit 94. The PTZ scheduling unit 96 continuously updates the priority of objects being tracked based on information provided by the PTZ system 20 and the object tracking unit 94, such as the current position, velocity, and acceleration of the PTZ system 20 and the objects.

The PTZ scheduling unit 96 communicates with a PTZ driver unit 98. Using the priorities set by the PTZ scheduling unit 96, the PTZ driver unit 98 sends appropriate commands to the PTZ controller of the PTZ system 20 so that the PTZ system 20 spends a predetermined amount of time on each object that is tracked. Alternatively, instead of using a single PTZ system and time-sharing among objects, multiple PTZ systems may be used to track multiple objects of interest simultaneously.

As shown in FIG. 6, the output of the PTZ system 20 may be viewed on a display 50 in real time. The display 50 may contain multiple windows for each of the objects being tracked. In addition, the output of the PTZ system 20 may also be recorded on recording equipment 52, such as a tape recorder or disk drive, for later viewing. If the output of the PTZ system 20 is recorded, advantageously a time stamp may also be recorded with the images. In addition, the output of the WAIS 10 may also be recorded for later viewing. By recording the output of the WAIS 10, a user is able to view not just detailed images of the objects of interest, but also their surroundings.

In an exemplary embodiment of FIG. 6, the WAIS 10 comprises a PARACAMERA from CYCLOVISION TECHNOLOGIES of New York, N.Y., used in conjunction with a Model GP KR222 camera from PANASONIC. The PTZ system 20 is a SONY CCD-IRIS camera mounted on a Model No. PTU-46-17.5 PTZ controller from DIRECTED PERCEPTION of Burlingame, Calif. The motion detection unit 92, object tracking unit 94, coordinate mapping unit 95, PTZ scheduling unit 96, and PTZ driver unit 98 are implemented in software within a general purpose computer 90. The general purpose computer 90 may be, for example, an INTEL PENTIUM PRO 200 MHZ system, running the MICROSOFT WINDOWS NT 4.0 operating system, and including a MATROX PPB frame grabber add-on board from MATROX ELECTRONIC SYSTEMS LTD., 1055 St. Regis Blvd., Dorval, Quebec, Canada H9P 2T4. The display 50 and recording equipment 52 may also be part of the general purpose computer 90.

Referring to FIGS. 7A through 7C, a flow-chart is shown detailing the steps of a preferred method for monitoring objects in an area. These steps may be programmed in software in a general purpose computer 90. An exemplary correspondence of the steps with the embodiment of FIG. 6 is shown by the dotted lines. Of course, it is clear that those skilled in the art may also easily implement the functionality of one or more of these steps in special-purpose hardware.

In step 702, an image frame I_t is retrieved from the frame grabber 30. If the image is a color image, the image frame I_t may consist of separate color channels as, for example, red, green, and blue channels. In that case, all of the following computations may be performed with respect to each color channel. Alternatively, the color channels may be summed up to obtain a black and white image.

Because images are prone to camera noise (i.e., changes in pixel intensities over time), in step 704, the image frame I_t is filtered to remove any such noise. Any known noise filter may be used as. An exemplary filter is a box filter with a four-by-four (4×4) box size. This filter takes a four-by-four set of pixels in the image frame I_t and generates a single output pixel that is the average of the intensities of the pixels in the set. Of course, this filter reduces the resolution of the image frame I_t by four. The noise filter produces a filtered image frame FI_t.

Since speed is critical in real-time applications, filtering is performed only in the image frame area that corresponds to the active imaging area of the WAIS 10. For example, if the WAIS 10 produces a circular image on a CCD, only the corresponding circular image area in the image frame I_t is filtered. In addition, to further maximize performance, running balances may be maintained as the scan lines of image frame I_t are read. For example, assuming that a four-by-four (4×4) box filter is used and that hypothetically the image frame I_t is twelve (12) pixels wide, three variables s_1, s_2, and s_3 may be used to store the sum of pixels 1 to 4, pixels 5 to 8, and pixels 9 to 12, respectively, when the first scan line of I_t is read. When the second scan line of I_t is read, the sums of pixels 1 to 4, pixels 5 to 8, and pixels 9 to 12 of the second scan line are added to s_1, s_2, and s_3, respectively. Variables

s_1, s_2, and s_3 are updated in the same manner when the third and fourth scan lines are read. After the fourth scan line is read, s_1, s_2 and s_3 are divided by sixteen to obtain the box filter output for the first three four-by-four (4×4) boxes in the image frame I_t. The process is repeated until all of the scan lines of I_t are read. In this manner, memory access time is minimized.

In step **706**, the filtered image frame FI_t is subtracted from the moving average image frame M_{t-1} to produce a difference image frame D_t. The moving average image frame M_{t-1} represents a historical average of all past image frames. Thus, if the difference image frame D_t is not zero, then something in the current image frame is different than in the past, and there is an indication of movement in the image. The reason the current image frame FI_t is compared to the moving average image frame M_{t-1}, instead of simply to the last image frame FI_{t-1}, is to account for gradual changes in the lighting of the monitored area.

In step **708**, the moving average image frame is updated. Any moving average function may be used. An exemplary function is shown in equation (8).

$$M_t=\alpha M_{t-1}+(1-\alpha)FI_t \tag{8}$$

An exemplary value of α in equation (8) is 0.75. Using a ratio for α with a denominator that is an exponential value of two (2) is advantageous because it allows the use of binary shifting to perform multiplication and division by α, instead of using floating point operations. Binary shifting is the shifting of bits of a binary-represented number. As is well known by those in the art, each time a binary number is shifted to the left, the binary number doubles; and each time a binary number is shifted to the right, the binary number is divided by two. It is also well known that the use of binary shifting is faster than the use of floating point operations and, thus, minimizes calculation time.

To account for any noise that may not have been filtered out in step **704**, in step **710**, each pixel of the difference image frame D_t is compared to a threshold value. Based on this comparison, a threshold image frame T_t is created. Each pixel in T_t has a value of "1" if the corresponding pixel in D_t is above the threshold value and a value of "0" if the corresponding pixel in D_t is below the threshold value. The pixels in T_t with a value of "1" indicate motion in the corresponding region of I_t. Advantageously, the step of comparing each pixel in D_t to a threshold value and generating T_t may be performed simultaneously with the step of subtracting FI_t from M_{t-1}.

Once regions of motion are detected in T_t, the regions must be associated with objects. This association is not as easy as associating each continuous region with an object because a single object may produce multiple regions of motion. For example, moving persons may produce movement in the regions of both their arms and legs. To determine which regions constitute a single object, image dilation is performed on T_t in step **712**. Image dilation consists of spreading or smearing those pixels in T_t that indicate motion (i.e., have a value of "1"). For example, for each pixel indicating motion in T_t, a box of pixels surrounding the motion-indicating pixel is selected, and the box is filled with the value "1". As a result of this image dilation process, separate regions merge together. The remaining continuous regions are characterized as single objects and are labeled for identification.

Once objects are associated with regions of motion in T_t, it is determined in step **714** whether any of these objects correspond to objects that have been previously identified. In general, such a determination will involve both temporal and spatial reasoning. A simple manner in which this determination can be made, however, is to compare the currently generated dilation frame with a previously-generated dilation frame and to assume that objects that overlap in the two frames are the same. Of course, more complicated and robust methods could also be used. For example, models of the objects could be built and could be tested against the behavior of objects in the current and past frames. After the current objects are correlated with the past objects, all unique objects are labeled for identification.

In step **716**, a selection is made as to which objects to track. The selection criteria is necessarily application specific, but examples of such criteria are the size, shape, duration of existence, and location of objects.

In step **718**, specific viewing parameters are generated for each object to be tracked. That is, each object is usually spread out over some area in the image. In this step, it is determined on which point of the object to focus. Such a determination may be performed, for example, by determining the centroid (center of mass) of each object's area in the dilated image frame. Alternatively, the center of the bounding box for each object in the dilated image frame may be used. More preferably, a weighted average of the centroid and the center of the bounding box may be used.

It is possible that, because of the time required for the calculations described above, the viewing parameters determined in step **718** will not generate a smooth trajectory for an object over time. Therefore, the video image of an object as viewed from the PTZ system may appear "jerky." To avoid this jerkiness, in step **720**, a smoothing function is applied to the viewing parameters generated in step **718**. Kalman filters, such as Wiener filters, have been tried and have been found to work robustly. A disadvantage to using these smoothing filters is that the smoothed viewing position of the object may lag behind the actual position of the object. To compensate for this effect, a feed-forward term is preferably added to the output of these smoothing filters. An exemplary feed-forward term is twice the difference between the previous smoothed viewing position and the previous actual object position. In addition, an adaptive filter, which changes the rate of acceleration of the viewing position based on the rate of acceleration of the object may also be used.

In step **722**, optionally, a perspective or panoramic display of the objects being tracked may be generated from the image frame I_t provided by the wide-angle imaging system based on the viewing parameters generated in step **720** and the size and center of the objects being tracked. Perspective and panoramic mapping is performed as discussed in relation to FIGS. **3A** and **3B**. Preferably, each object is displayed in its own window.

In step **724**, the smoothed viewing parameters are mapped from the WAIS coordinate system to the PTZ coordinate system, as described previously. In step **726**, scheduling of the objects is performed. A simple first-in, first-out (FIFO) queuing system in which the first-observed objects receive the highest priority may be used. Of course, more complicated heuristics could also be implemented. Once scheduling is completed, in step **728**, the PTZ driver unit **98** converts the PTZ object coordinates into manufacturer-specific codes for the PTZ controller of the PTZ system **20**.

FIG. **8** illustrates a preferred embodiment of a wide-angle imaging system for use with the present invention. The WAIS **10** comprises a camera **100** having a telecentric means **110** attached to it, which are positioned below a paraboloid-shaped mirror **120**. As described fully in U.S. patent application Ser. No. 08/644,903, filed on May 10,

1996, (issued as U.S. Pat. No. 5,760,826 on Jun. 2, 1998) entitled "An Omnidirectional Imaging Apparatus," and in the continuation-in-part application of the same title, U.S. patent application Ser. No. 08/986,082, filed on Dec. 5, 1997, (currently pending) both of which are incorporated by reference herein, the paraboloid-shaped mirror **120** orthographically reflects any principal rays of a scene that would otherwise pass through the focus of the paraboloid. The telecentric means **110** filters out any rays of light that are not orthographically reflected by the paraboloid-shaped mirror **120**. The telecentric means **110** may be a telecentric lens, a telecentric aperture, or a collimating lens used in combination with imaging optics.

When the paraboloid-shaped mirror is truncated at a plane passing through its focus and normal to its paraboloidal axis, the paraboloid-shaped mirror is capable of orthographically reflecting principal rays from an entire hemisphere. Advantageously, therefore, the WAIS **10** using the paraboloid-shaped mirror **120** is able to provide a hemispherical field of view from a single viewpoint (i.e., from the focus of the paraboloid). Moreover, since the WAIS **10** has a single viewpoint, its images can be mapped to perspective and panoramic views without any distortion.

Alternatively, other catadioptric imaging systems may be used in the present invention. As used in this specification and the appended claims, the term "catadioptric" refers to an imaging system that uses a combination of reflecting surfaces (such as mirrors) and refracting surfaces (such as lenses). Examples of other catadioptric imaging systems that may be used as the wide-angle imaging system of the present invention include, as shown in FIG. **9**, a hyperboloidal or ellipsoidal mirror **140** used in conjunction with a perspective lens **130**. Examples of hyperboloidal and ellipsoidal mirrors are disclosed in Yamazawa et al. and Rees, which have been discussed earlier. Hyperboloidal and ellipsoidal systems may also be configured to provide a single viewpoint and, thus, as with paraboloidal systems, the images produced by such systems may be mapped to perspective or panoramic views without distortion. Nonetheless, these systems are less favored than paraboloidal systems because they require complex calibration and implementation.

Additionally, although it is less desirable, catadioptric systems containing other curved surfaces that do not provide images from a single viewpoint, such as spherical or conical surfaces, may also be used for the wide-angle imaging system of the present invention. Although they do not provide images with a single viewpoint, such systems are capable of serving the main purpose of the wide-angle imaging system of the present invention - - - i.e., to detect regions of interest (and not necessarily to provide distortion-free visual details of those regions). Thus, although it may be desirable, it is not critical to provide images with a single viewpoint from the wide-angle imaging system of the present invention.

In addition to curved surfaces, various arrangements of planar mirrors may be used for the wide-angle imaging system of the present invention. For example, in FIG. **10**A, triangular planar mirrors **150***a* are arranged in a pyramid shape to reflect a wide-angle field of view to a single camera **100**. As another example of a catadioptric system with planar mirrors, in FIG. **10**B, polygonal planar mirrors **150***b* are arranged in a polyhedral shape to reflect a wide-angle field of view to multiple cameras **100**. A specific example of this embodiment is disclosed in U.S. Pat. No. 5,539,483 to Nalwa, which was discussed earlier.

Instead of a catadioptric system, commercial wide-angle lenses may also be used for the wide-angle imaging system of the present invention. For example, as shown in FIG. **11**, a wide-angle lens **160**, such as a 2 mm focal-length COMPUTAR EMH200, could be mounted on a camera **100** on a ceiling **5** to provide a 115° view of the area beneath it. Alternatively, if a wider field of view is necessary, a fish-eye lens **170**, as illustrated in FIG. **12**, such as a NIKON 8 mm focal-length F2.8 lens, could be used to provide a substantially hemispherical field of view.

In addition, as shown in FIGS. **15**A and **15**B, the wide-angle imaging system of the present invention may comprise multiple camera systems **200**. The camera systems **200** may contain non-overlapping fields of view as in FIG. **15**A, or they may contain overlapping fields of view as in FIG. **15**B. In addition, each camera system **200** may be either a narrow-angle or wide-angle camera system.

Although the present invention has been described with reference to certain preferred embodiments, various modifications, alterations, and substitutions will be known or obvious to those skilled in the art without departing from the spirit and scope of the invention, as defined by the appended claims.

We claim:

1. The surveillance and monitoring system for monitoring an area, comprising:

(a) a first imaging system having a wide-angle field of view approximately equal to or greater than said area, said first imaging system providing a direction information for at least one portion of said area;

(b) one or more second imaging systems having adjustable view settings and receiving said direction information from said first imaging system, said one or more second imaging systems positioned to view said at least one portion of said area and being capable of producing images of said at least one portion using said direction information and predetermined depth information relating a depth of said at least one portion of said area at a fixed height from a predetermined base level; and

(c) one or more controls for controlling said adjustable view settings of said one or more imaging systems.

2. The surveillance and monitoring system of claim **1**, wherein said area is substantially hemispherical and said first imaging system has a substantially hemispherical field of view.

3. The surveillance and monitoring system of claim **1**, wherein said adjustable view settings include a pan setting for adjusting the pan angle of said one or more second imaging systems with respect to said area.

4. The surveillance and monitoring system of claim **1**, wherein said adjustable view settings include a tilt setting for adjusting the tilt angle of said one or more second imaging systems with respect to said area.

5. The surveillance and monitoring system of claim **1**, wherein said adjustable view settings include zoom settings for adjusting the zoom of said one or more second imaging systems with respect to said portions of said area.

6. The surveillance and monitoring system of claim **1**, wherein said first imaging system is a catadioptric system comprising a reflecting surface positioned to reflect an image of said area and one or more image sensors optically coupled to said reflecting surface.

7. The surveillance and monitoring system of claim **6**, wherein said reflecting surface comprises a truncated, substantially paraboloid-shaped mirror.

8. The surveillance and monitoring system of claim **6**, wherein said reflecting surface comprises a truncated, substantially hyperboloidal-shaped mirror.

9. The surveillance and monitoring system of claim **6**, wherein said reflecting surface comprises a substantially ellipsoidal-shaped mirror.

10. The surveillance and monitoring system of claim 6, wherein said reflecting surface comprises one or more curved mirrors.

11. The surveillance and monitoring system of claim 6, wherein said reflecting surface comprises one or more planar mirrors.

12. The surveillance and monitoring system of claim 1, wherein said first imaging system comprises imaging optics and one or more image sensors optically coupled to said imaging optics.

13. The surveillance and monitoring system of claim 12, wherein said imaging optics comprises a wide-angle lens.

14. The surveillance and monitoring system of claim 12, wherein said imaging optics comprises a fish-eye lens.

15. The surveillance and monitoring system of claim 1, wherein said first imaging system comprises a plurality of camera systems.

16. The surveillance and monitoring system of claim 1, further comprising a monitoring station including:

one or more displays, at least one display coupled to said first imaging system for displaying an image of said area and at least one display coupled to said one or more second imaging systems; and

an input arrangement selecting a region of interest displayed on said at least one display coupled to said first imaging system, said input arrangement operatively coupled to said one or more controls for controlling said adjustable view settings such that at least one of said one or more second imaging systems is positioned to view said region of interest.

17. The surveillance and monitoring system of claim 1, wherein said first imaging system provides an image signal representative of said area, and further comprising an image signal processing apparatus coupled to said first imaging system to convert said image signal into image signal data.

18. The surveillance and monitoring system of claim 17, wherein said image signal processing apparatus includes an arrangement which maps said image signal data into a Cartesian-coordinate system to produce a perspective image.

19. The surveillance and monitoring system of claim 17, wherein said image signal processing apparatus includes an arrangement which maps said image signal data into a cylindrical-coordinate system to produce a panoramic image.

20. The surveillance and monitoring system of claim 1, further comprising a motion detection arrangement coupled to said first imaging system which detects objects in motion in said area.

21. The surveillance and monitoring system of claim 20, further comprising a tracking arrangement which tracks one or more of said objects in motion in said area, said tracking arrangement having an input coupled to said motion detection arrangement and an output coupled to said one or more controls for controlling said adjustable view settings.

22. A surveillance and monitoring system for monitoring an area, comprising:

(a) a first imaging system having a wide-angle field of view approximately equal to or greater than said area;

(b) a motion detection arrangement coupled to said first imaging system which detects objects in motion in said at least one portion;

(c) a tracking arrangement coupled to said motion detection arrangement which tracks at least one of said detected objects in motion and generates direction information relating to said at least one of said detected objects; and

(d) at least one second imaging system receiving said direction information and being capable of producing images of said at least one of said detected objects using said direction information and predetermined depth information relating a depth of said at least one of said detected objects at a fixed height from a predetermined base level.

23. A method for monitoring an area, comprising the steps of:

(a) sensing a global image of said area with a first imaging system having a field of view approximately equal to or greater than said area;

(b) detecting a region of interest within said global image;

(c) sensing one or more detailed images of said region of interest with at least one second imaging system;

(d) providing, from said first imaging system, direction information for said region of interest; and

(e) producing, with at least one second imaging system, said one or more images of said region of interest using said direction information and predetermined depth information relating a depth of said at region of interest at a fixed height from a predetermined base level.

24. A method for monitoring an area, comprising the steps of:

(a) positioning a first imaging system to view said area, said first imaging system having a wide-angle field of view approximately equal to or greater than said area;

(b) positioning one or more second imaging systems having adjustable view settings to view at least one portion of said area, each of said one or more second imaging systems being capable of producing images of said at least one portion with a resolution greater than said first imaging system;

(c) sensing an image of said area with said first imaging system;

(d) detecting a region of interest within said sensed image;

(e) generating, from said first imaging system, direction information for said detected region;

(f) producing, with said one or more second imaging systems, said image using said direction information and predetermined depth information relating a depth of said at least one portion of said area at a fixed height from a predetermined base level; and

(g) controlling said adjustable view settings so as to view said region of interest with at least one of said one or more second imaging systems.

25. A method for monitoring one or more objects in motion in an area, comprising the steps of:

(a) positioning a first imaging system to view said area, said first imaging system having a wide-angle field of view approximately equal to or greater than said area;

(b) positioning one or more second imaging systems having adjustable view settings to view at least one portion of said area, each of said one or more second imaging systems being capable of producing images of said at least one portion with a resolution greater than said first imaging system;

(c) sensing images of said area with said first imaging system;

(d) detecting said one or more objects in motion from said sensed images;

(e) tracking one or more of said detected objects;

(f) generating, from said first imaging system, direction information for said one or more detected objects;

(g) producing, with said one or more second imaging systems, said image using said direction information and predetermined depth information relating a depth of said at least one portion of said area at a fixed height from a predetermined base level; and

(h) controlling said adjustable view settings so as to view said tracked objects with at least one of said one or more second imaging systems.

26. The method for monitoring one or more objects in motion in an area of claim 25, wherein said step of detecting comprises:

generating a series of image frames at predetermined time intervals from said sensed images;

filtering said series of image frames for noise;

calculating a moving average frame from a subset of said series of image frames comprising the set from the first image frame to the next-to-last image frame;

subtracting the filtered, last image frame of said series of image frames from said moving average frame to produce a difference image frame;

comparing each pixel of said difference image frame to a predetermined threshold value to produce a threshold image frame indicative of regions of motion in said area;

defining a first group of objects associated with said subset of said series of image frames;

associating a second group of objects with said regions of motion in said threshold image frame; and

generating a third group of objects comprising all unique objects in said first and second groups.

27. The method for monitoring one or more objects in motion in an area of claim 26, wherein the step of tracking comprises:

selecting a fourth group of objects to be tracked from said third group of objects on the basis of a predetermined criteria;

determining a focus point for each object in said fourth group of objects; and

applying a smoothing function to the focus point of each object.

28. The method for monitoring one or more objects in motion in an area of claim 25, wherein said step of controlling comprises mapping the coordinates of said tracked objects from the coordinate system of said first imaging system into the coordinate system of at least one of said one or more second imaging systems.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,215,519 B1
DATED : April 10, 2001
INVENTOR(S) : Nayar et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title page,
Item [56], **References Cited**, U.S. PATENT DOCUMENTS,
insert -- 5,760,876 6/1998 Nayar ....348/36 --;

OTHER PUBLICATIONS,
Under "Primary Image–etc.," (fourth occurrence), "thml," should read -- html, --;
Under "Primary Image–etc.," (sixth occurrence), "Zome" should read -- Zone --;
Under S. Bogner et al., "Defence" should read -- Defense --
Under E. Hall et al., "Illimination" should read --Illumination --
Under V. Nalva, "Nalva" should read -- Nalwa --
Under S.E. Chen, "Envbironment" should read -- Environment --
Under K. Yamazawa et al., "Internation" should read -- International --

Column 1,
Line 4, insert -- The U.S. Government has certain rights in this invention pursuant to the terms of DARPA Contract No. N00014-97-1-0553 and National Science Foundation Grant No. IRI-93-57594. --
Line 45, "---" should read -- – --

Column 6,
Line 65, "includes" should read -- include --

Column 9,
Line 16, "d_{pov}=d_{woy}–d_{wpy}" (line 16 in its entirety) should be deleted

Column 10,
Line 21, "MHZ" should read -- MHz --
Line 60, "$I_r$are" should read -- I_r are --

Column 11,
Line 42, "$D_r$is" should read -- D_r is --

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,215,519 B1
DATED : April 10, 2001
INVENTOR(S) : Nayar et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 13,
Line 1, "1996," should read -- 1996 --; and "1998)" shoud read -- 1998), --
Line 5, "1997, (currently pending)" should read -- 1997 (currently pending), --
Line 49, "---" should read -- – --

Column 14,
Line 22, "The" should read -- A --

Column 15,
Line 12, "comprises" should read -- comprise --
Line 14, "comprises" should read -- comprise --

Column 16,
Line 22, "at" should be deleted

Column 18,
Line 11, "a" should be deleted

Signed and Sealed this

Twenty-sixth Day of March, 2002

Attest:

JAMES E. ROGAN
Director of the United States Patent and Trademark Office

Attesting Officer

United States Patent [19]

Kloots et al.

[11] Patent Number: 4,616,257

[45] Date of Patent: Oct. 7, 1986

[54] HEADLIGHT

[75] Inventors: Jacobus Kloots, Sturbridge; Frans G. Van Der Bel, Southbridge, both of Mass.

[73] Assignee: Luxtec Corporation, Sturbridge, Mass.

[21] Appl. No.: 744,801

[22] Filed: Jun. 13, 1985

[51] Int. Cl.⁴ H04N 7/18

[52] U.S. Cl. 358/93; 358/88; 358/108; 362/32; 362/105; 362/253; 362/268; 362/285; 362/371; 362/419; 362/804

[58] Field of Search 362/32, 105, 106, 253, 362/268, 285, 296, 371, 419, 804; 128/23; 353/29; 250/227, 578; 358/88, 93, 108

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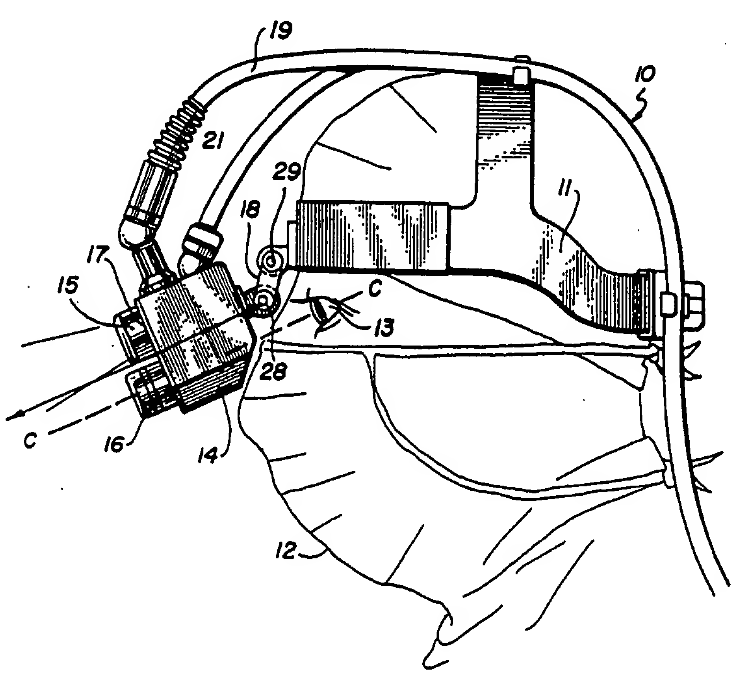
Primary Examiner—Randall L. Green
Attorney, Agent, or Firm—Blodgett & Blodgett

[57] ABSTRACT

Head-mounted illuminating apparatus, including a visual image pickup means and an audio pickup means for transmittal to a remote station.

8 Claims, 10 Drawing Figures



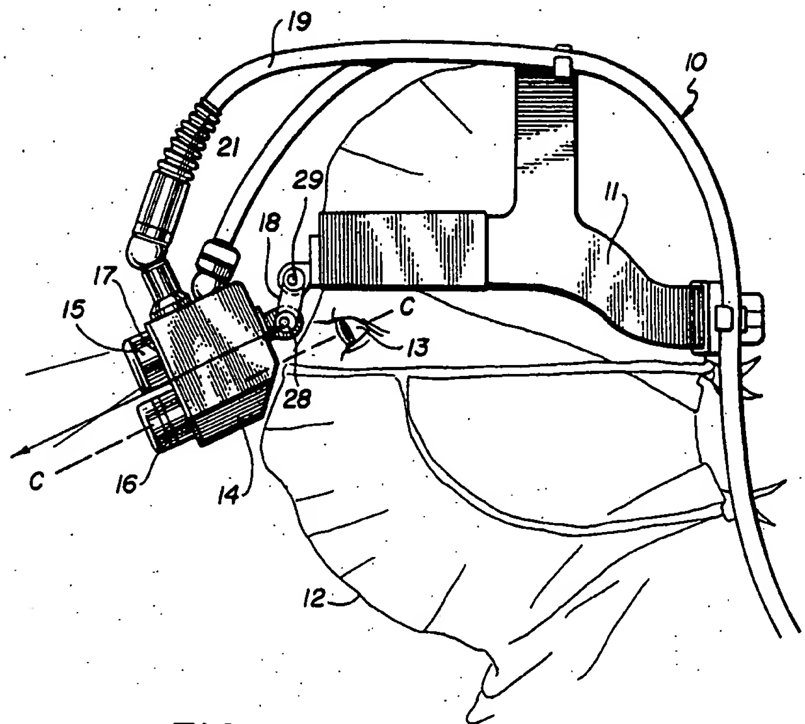


FIG. 1

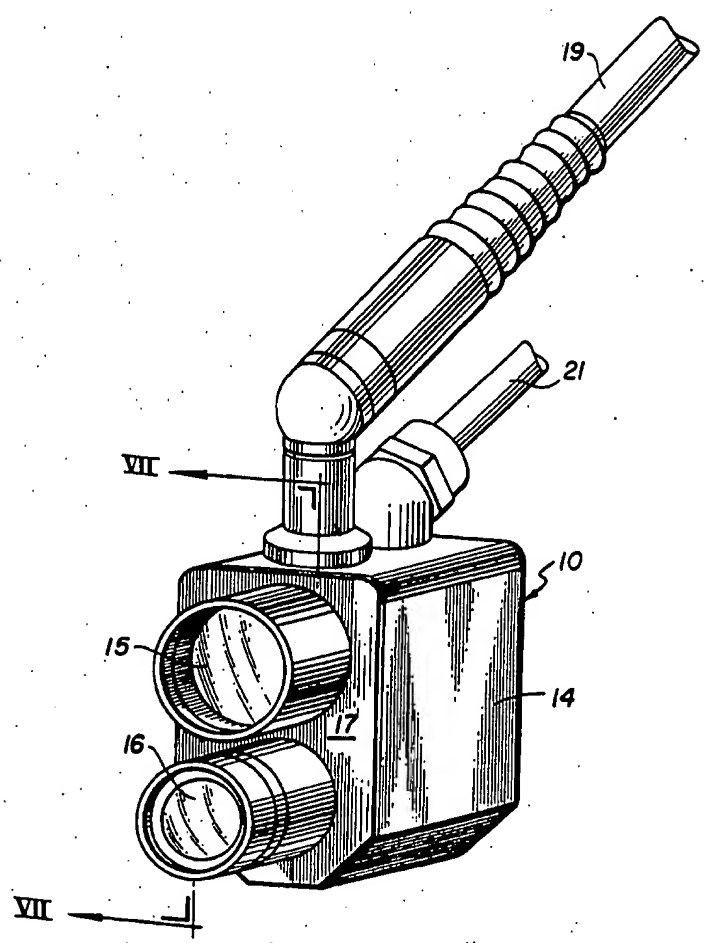


FIG. 2

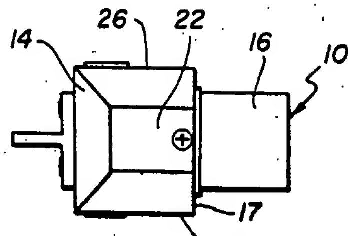


FIG. 6
BOTTOM VIEW

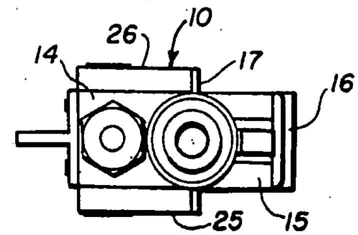


FIG. 3
TOP VIEW

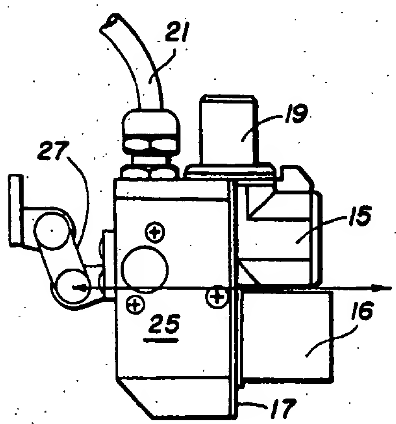


FIG. 8
R.H. SIDE VIEW

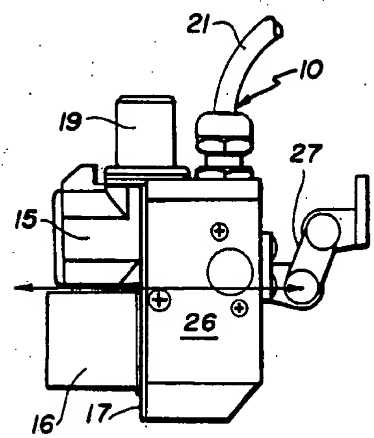


FIG. 7
L.H. SIDE VIEW

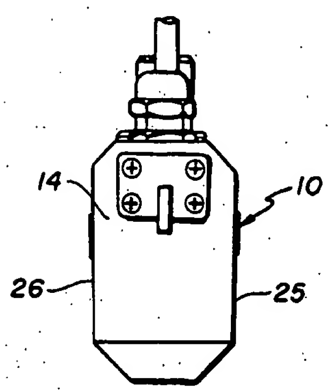


FIG. 4
BACK VIEW

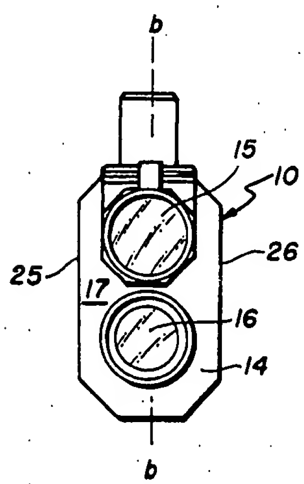


FIG. 5
FRONT VIEW

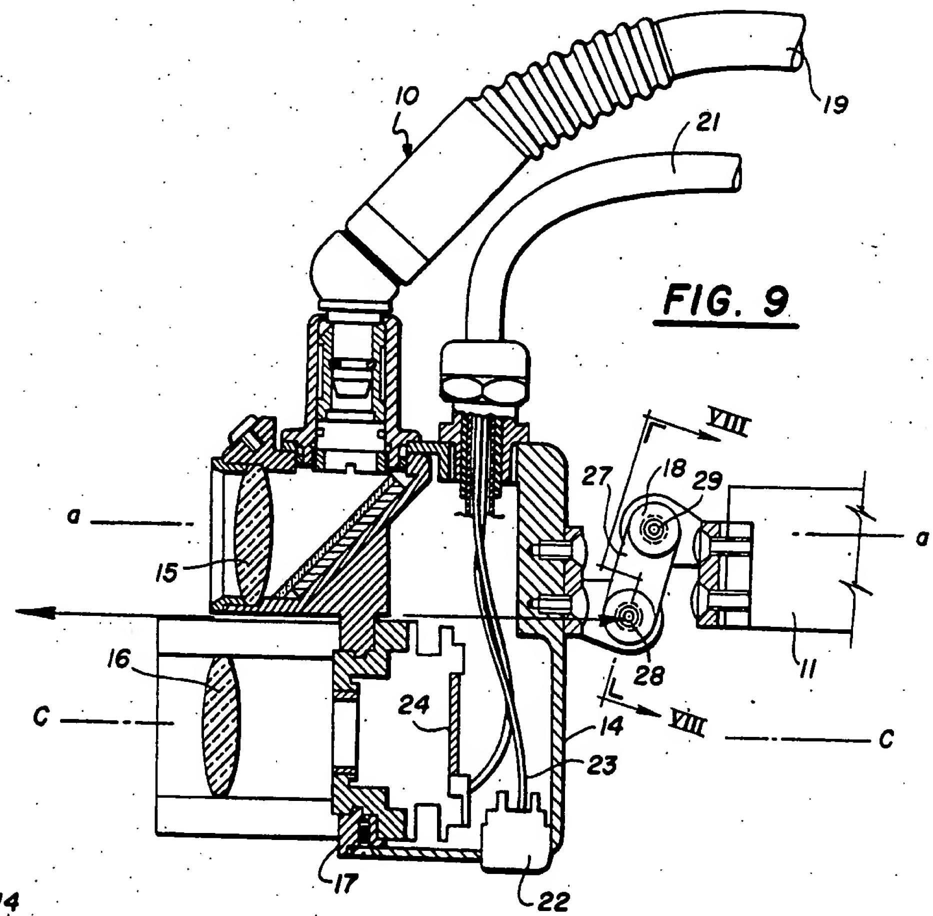

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FIG. 9

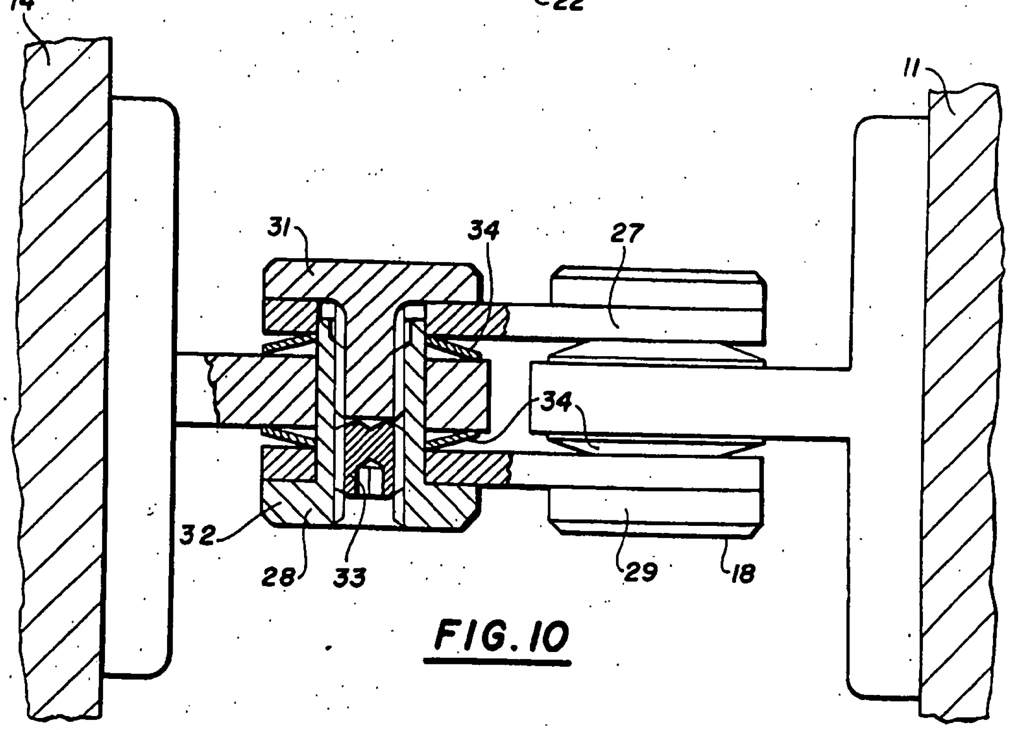
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FIG. 10

HEADLIGHT

BACKGROUND OF THE INVENTION

For many years, the need for a physician and other type of worker to illuminate his work area (where fine work is to be done) has been supplied by the use of a concave mirror with a central axis aperture for the physician to look through. At times the normal room light has been supplemented by a high-intensity incandescent light associated with the mirror. With the advent of fibre-optics, it has been common practice to bring the light down to the desired work area by use of a fibre-optic cable that is attached to the head band of the apparatus. It has recently became more and more important that the image of the work area be made available for observation by students and for keeping a record of the operation. Since the surgeon's head blocks any view from behind him, a television camera or movie camera necessarily had to operate from the side and, of course, could not possibly see the same image as the surgeon. With many situations (where the operation is taking place deep within a body cavity, for instance) a television camera located at the side does not see any of the manipulation involved in the operation. It has been suggested that a television or movie camera be attached to the headband adjacent the illuminating means, but the suggested constructions for doing this involved a number of problems. First of all, having both the illumination and the camera directed at the work area is a problem, since the work area can change in various respects. Furthermore, the width of conventional equipment means that a large object must be inserted between the surgeons eyes, so that he has to move his head around to observe his work area. Often only one eye at a time would be able to look at the operation site. Furthermore, it would be desirable if, during the operation, the surgeon were not only able to send a picture to a remote station of the operation in color, but also to describe verbally what is happening. Not only could this be used for instruction purposes, but also for making a record of the operation for use in a possible malpractice suit or the like. These and other difficulties experienced with the prior art devices have been obviated in a novel manner by the present invention.

It is, therefore, an outstanding object of the invention to provide a headlight capable of not only illuminating the work area, but also transmitting a video image and an audio signal to a remote location for use in instruction and recording.

Another object of this invention is the provision of a headlight for surgeons in which a visual image and sound transmittal takes place without the need for attention by the surgeon.

A further object of the present invention is the provision of a headlight including a combination illumination, T.V. transmittal, and audio transmittal apparatus, in which the surgeon only need adjust the illuminating means and the other functions perform automatically.

It is another object of the instant invention to provide a medical headlight in which illuminating means and image transmittal means are arranged so that they do not block the surgeon's view.

A still further object of the invention is the provision of a surgical headlight which is simple in construction, which is economical to manufacture, and which is capable of a long life of useful service with a minimum of maintenance.

It is a further object of the invention to provide a headlight in which the illumination source, image transmission, and audio transmission are combined in apparatus which is relatively narrow, so that vision is not obstructed when the apparatus is located between the eyes.

It is a still further object of the present invention to provide a headlight in which the illumination area and the image pickup area remain coextensive despite substantial adjustments relative to the headband.

With these and other objects in view, as will be apparent to those skilled in the art, the invention resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

SUMMARY OF THE INVENTION

In general, the invention consists of a headlight having a headband adapted to fit snugly on a human head above the eyes and a main housing with an illuminating lense and a viewing lense extending from a narrow surface of the main housing. The viewing lense includes an integrated circuit chip acting as a light-to-electrical signal transducer. The set of lines of the lenses lie in a vertical plane that is midway between the users eyes and intersect at a substantial distance from the said surface. A bracket holds the housing in the general level of the eyes of the user and midway between the eyes, the bracket permitting adjustment of the housing relative to the eyes. The adjustment permitted consists of distance, level, and angle in the vertical plane. A light source fibre-optic cable extends from the top of the housing and is connected to the illuminating lense. A communication cable which is connected to the viewing chip and which also extends from the top of the housing transmits an image to a viewing screen that is substantially the same as the image seen by the eyes. A microphone is mounted in the lower part of the housing.

Specifically, the illuminating lense generates a light beam of sufficient diameter that it is intersected by the centerline of the viewing lense over a wide range of distances from the housing surface. The centerline of the viewing lense is located midway between the eyes of the user and is located on a level therewith, so that the image picked up is exactly the same as the image seen by the eyes. The diameter of the two lenses and the thickness of the housing is very small, so that neither housing nor lenses interferes with the users line-of-sight. The bracket consists of a link that is pivotally attached to the rear of the main housing to provide a horizontal pivotal axis that is midway between the centerlines of the two lenses; because of this arrangement, angular adjustment can take place with a minimum of change in vertical and horizontal location of the elements relative to the headband and to the users eyes.

BRIEF DESCRIPTION OF THE DRAWINGS

The character of the invention, however, may be best understood by reference to one of its structural forms, as illustrated by the accompanying drawings, in which:

FIG. 1 is a side elevational view of the headlight embodying the principles of the present invention,

FIG. 2 is a perspective view of a portion of the headlight,

FIG. 3 is a plan view of the headlight,

FIG. 4 is a rear elevation view of the headlight,

FIG. 5 is a front elevational view of the headlight,

FIG. 6 is a bottom plan view of the headlight,

FIG. 7 is a left hand side elevational view of the invention,

FIG. 8 is a right hand side view of the invention,

FIG. 9 is a vertical sectional view of the headlight taken on the line VII—VII of FIG. 2, and

FIG. 10 is a partially-sectioned view of a part of the apparatus taken on the line VIII—VIII of FIG. 7.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIG. 1, which best shows the general features of the invention, the headlight, indicated generally by the reference numeral 10, is shown as having a headband 11 mounted on the head 12 of a user, such as a surgeon, whose eyes are indicated by the reference numeral 13. Mounted on the headband is a main housing 14 having a surface or face 17 directed toward the operating area. From the face 17 extends an illuminating lense 15 and a viewing lense 16. The centerline A—A of the lense 17 and the centerline C—C of the lense 16 lie in a vertical plane midway between the user's eyes 13. They intersect at a substantial distance from the face 17. A bracket 18 holds the housing 14 on the level with the eyes 13 of the user and lies midway between the eyes. The bracket permits the adjustment of the housing 14 relative to the headband 11 and the eyes. The adjustment permitted is of distance, level, and angle in the said vertical plane.

The light source fibre-optic cable 19 extends from the top of the housing 14 and is connected to the illuminating lense 15. A communication cable 21 also extends from the top of the housing 14 to transmit an image to a viewing screen (not shown) that is substantially the same as the image seen by the eyes 13.

As is evident in FIGS. 2 to 8, the housing 14 is a right parallelepiped and the face 17 is a narrow rectangular shape whose width is such that the eyes 13 can observe the work area on either side of the unit without interference by the housing or lense.

Referring to FIG. 9, it can be seen that a microphone 22 is mounted in the bottom of the housing 14 and is provided with a cable 23 leading into the communication cable 21 and is connected eventually to an amplifier, a loudspeaker, and a recorder at a remote location.

The illuminating lense 15 forms part of a system shown and described in the Kloots U.S. Pat. No. 4,516,190 which issued on May 7, 1985. As such, the lense 15 receives light from a mirror after the light arrives in a fibre-optic cable 19 from a light source that is well known in the art. The light beam that leaves the lense 15 has a large diameter and, since its centerline A—A is at a slight angle to the centerline C—C of the viewing lense 16, the viewing lense will pick up an illuminated area over a wide range of distances from the face 17 of the housing. The viewing lense is interchangeable with a set of lenses of different focal length to permit viewing over various distances. The centerline of the viewing lense C—C is between the eyes 13 of the user and on a level therewith, so that the image picked up is exactly the same as the image seen by the eyes.

A transducer in the form of an integrated circuit chip 24 is located in the housing behind the viewing lense 16 that acts as a light-to-electrical transducer, the electrical signal being carried back into the communication cable 21. The chip 24 is of the well-known type in which light images which strike the surfaces of the chip are converted to electrical signals that can be removed by an electrical cable and placed on a CRT screen at a remote location. In the preferred embodiment, the chip 24 is made by SONY and identified by them is their Type 1CX016K. The chip has 384 horizontal picture elements and 491 vertical picture elements with a sensing area of 8.8 mm. by 6.6 mm. Its horizontal drive frequency is 7.16 mega Hz (2 Fsc) and a vertical drive frequency of 15.75 KHz. Its structure is that of an interline transfer charge couple device and the cell size is 23.0 micrometers (horizontal) by 13.4 micro-meters (vertical). This chip can be used in either the NTSC, PAL, PAL-M, or the SECAN system.

Referring particularly to FIGS. 9 and 10, it can be seen that the bracket 18 is provided with a link 27 that is attached by a pivot 28 with the rear of the main housing 18 to provide a first horizontal pivotal axis that is midway between the centerlines of the two lenses 15 and 16. The link is attached at the other end by a pivot 29 to the headband 11 to provide a second horizontal pivotal axis that is on the level above the first pivotal axis. In this way, angular adjustment can take place with a minimum of change in vertical and horizontal location of the lenses relative to the headband and the users eyes 13. Suitable means is provided in the pivots 28 and 29 to adjust the friction, so that the adjustments take place readily and still maintain location during activity of the user.

As is particularly evident in FIG. 5, the housing 14 is provided with spaced parallel sides 25 and 26 which define the surface 17. The distance between the sides is less than the distance between the users eyes 13, and the lenses 15 and 16 are small enough to be entirely encompassed between the sides, so that neither housing nor lenses interfere with the users line-of-sight.

The operation and advantages of the present invention will now be readily understood in view of the above description. The apparatus is provided with external remote equipment which generates a twin beam F.O. halogen light passing through the cable 19. Furthermore, the microphone 22 is connected by its cable 23 to suitable audio amplifying equipment which in turn is connected either to loudspeakers or to recording equipment to record sound during the operation. The video lense 16 is located to project an image onto the chip 24 which is connected by electrical cable to suitable amplifying and raster equipment to provide for reproducing the image on a cathode ray tube screen in the well-known manner. Initially, the headband 11 is placed on the head 12 of the surgeon and he then adjusts the position of the housing 14 by moving it about the pivots 28 and 29 associated with the bracket 18. Because of the way that the pivots 28 and 29 are constructed, suitable friction is provided, this being associated with the fact that the halves of the pivot are screwed together in the presence of Belleville springs to adjust the friction. The pivot 28, for instance, consists of two halves 31 and 32 which are screwed together and are locked by a set screw 33. Belleville springs 34 are suitably located between the heads of the halves 31 and 32 to press against the link 27 and allow for adjustment of friction in the pivot. A certain amount of adjustment of this friction is desirable before the apparatus is to be used in the operating room. The light beam emitted by the illuminating lense 15 is projected downwardly against the work area where the operation is taking place. The surgeon's eyes 13 lie substantial distances on either side of the sides 25 and 26 of the housing 14 so he

is able to observe the work area without it blocking his view. The centerline C—C of the viewing lense 16 always intersects the viewing area and moves with the beam from the lense 15, despite any adjustments relative to the headband 11 and despite any movement of the surgeon's head as he works. This means that the image picked up by the viewing lense 16 (and carried back to the chip 24) is exactly the same image observed by the surgeon as he works. This means that, ultimately, any observer of the CRT screen will see exactly what the surgeon sees. Furthermore, if a recording is made of the proceedings, the recording shows exactly what the surgeon sees and does. This, combined with the fact that the surgeon will be describing the operation verbally for the receipt by the microphone 22, makes for a complete educational demonstration of the surgical operation, as well as the possibility of making a complete record of it for use (for instance) in a malpractice suit.

It can be seen that the present invention has a number of decided advantages over the equipment of the prior art. First of all, the use of an audio pickup microphone 22 at the bottom of the housing 14 means that it is readily available for the surgeon to describe his procedures. The use of the integrated circuit chip 24 provides for an image of great clarity and discrimination to be carried back to the educational demonstration unit or to the recording equipment. The fact that the centerline of the viewing lense 16 is directly in line with the lines extending from the eyes 13 of the surgeon to the work area, means that the image is exactly the same as that observed by the surgeon. When he moves his head or moves the housing 14 (to have the beam from the illuminating lense 15 fall on the area in which he is working), he is automatically causing the viewing lense to observe what his eye sees. This overcomes the problem of the prior art where T.V. cameras or the like were located to one side of the surgeons head and the operators are underfoot. It was impossible, of course, to shoot the T.V. camera line-of-sight through the surgeon's head and, therefore, in many instances a true picture of the procedure could not be picked up. The use of the integrated circuit chip for transmitting the image overcomes the problem that the fibre-optic transmission had in the past of giving a weak signal with poor resolution. The present apparatus, therefore, makes it possible to enjoy a coaxial line-of-vision mode in the instruction of students and the recording of operations (similar to surgical procedures). This is particularly important where the user is operating in a deep narrow cavity or close to the operation, such as in a interocculor lense insertion in the eye. One of the attributes of the apparatus that makes these advantages possible is the use of small lenses mounted in the housing 14, so that there is no blocking of the surgeon's view, even in the case of persons whose interocculator distance is small.

It is obvious that minor changes may be made in the form and construction of the invention without departing from the material spirit thereof. It is not, however, desired to confine the invention to the exact form herein shown and described, but it is desired to include all such as properly come within the scope claimed.

The invention having been thus described, what is claimed as new and desired to secure by Letters Patent is:

1. Headlight, comprising:

(a) a headband adapted to fit snugly on a human head above the eyes,

(b) a main housing having an illuminating lense system and a viewing lense fixedly mounted in and extending from one face of the main housing, the centerlines of the lenses lying in a vertical plane midway between the user's eyes and intersecting at a substantial distance from the said face,

(c) a bracket holding the housing on a level with the eyes of the user and midway between the eyes, the bracket permitting adjustment of the housing relative to the eyes, the adjustment permitted being of distance, level, and angle in the said vertical plane,

(d) a light source fibre-optic cable extending from the top of the housing and connected to the illuminating lense system to provide it will light,

(e) a light-signal to electrical-signal transducer located in the housing behind the viewing lense, and

(f) a communication cable connected to the tranducer and extending from the top of the housing to transmit an image from the transducer to a viewing screen that is substantially the same as the image seen by the eyes.

2. Headlight as recited in claim 1, wherein a microphone is mounted on a lower portion of the housing, and a cable extends from the microphone into the communications cable.

3. Headlight as recited in claim 1, wherein the illuminating lense system rceives light from the fibre-optic cable and generates a light beam of sufficient diameter that the focal point of the viewing lense lies within the beam over a wide range of working distances from the housing face.

4. Headlight as recited in claim 1, wherein the centerline of the viewing lense is located midway between the eyes of the user and on a level therewith, so that the image picked up is exactly the same of the image seen by the eyes.

5. Headlight as recited in claim 1, wherein the transducer is in the form of an integrated circuit chip.

6. Headlight as recited in claim 1, wherein the housing is provided with spaced, parallel sides defining the said face, the distance between the sides being less than the distance between the user's eyes, and wherein the lenses are entirely enclosed between the sides, so that neither housing nor lenses interferes with the user's line-of-sight.

7. Headlight as recited in claim 1, wherein the bracket consists of a link that is attached by a pivot to the rear of the main housing to provide a first horizontal pivotal axis that is midway between the centerlines of the two lenses and that is attached by a pivot to the headband to provide a second pivotal axis that is on a level above the said first pivotal axis, so that angular adjustment can take place with a minimum change in vertical and horizontal positioning relative to the headband and the user's eyes.

8. Headlight, comprising:

(a) a headband, adapted to fit snugly on a human head above the eyes,

(b) a main housing having an illuminating lense system and a viewing lense fixedly mounted in and extending from a narrow face of the main housing, the viewing lense including integrated circuit chip acting as a light-to-electrical signal transducer, the centerlines of the lenses lying in a vertical plane midway between the user's eyes and intersecting at a substantial distance from the said face,

(c) a bracket holding the housing in the general level of the eyes of the user and midway between the

eyes, the bracket permitting adjustment of the housing relative to the eyes, the said adjustment being of distance, level, and angle in the said vertical plane,

(d) a light source fibre-optic cable extending from the top of the housing and connected to the illuminating lense system to provide it with light,

(e) a communication cable connected to the integrated circuit chip and also extending from the top of the housing to transmit an image from the chip to a viewing screen, which image is substantially the same as the image seen by the eyes, and

(f) a microphone mounted in the lower part of the housing for receiving voice material for transmission to a remote location.

* * * * *

United States Patent [19]

Brasket

[11] **Patent Number: 4,862,333**

[45] **Date of Patent: Aug. 29, 1989**

[54] CORNER WALL LAMP

[76] Inventor: Denis R. Brasket, 2745 Winnetka Ave. North - #185, Golden Valley, Minn. 55427

[21] Appl. No.: 225,793

[22] Filed: Jul. 29, 1988

[51] Int. Cl.[4] F21S 1/02

[52] U.S. Cl. 362/147; 362/294; 362/373; 362/307; 362/455

[58] Field of Search 362/145, 147, 125, 126, 362/151, 432, 294, 373, 368, 806, 311, 307, 433, 455

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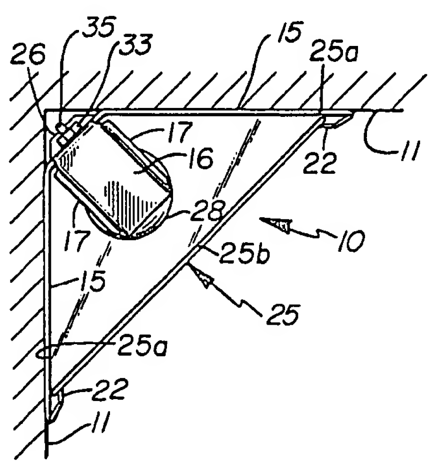
[57] ABSTRACT

A corner lamp is attached to the corner of a room defined by the orthogonal relation of two adjoining walls and the ceiling of a room. The lamp is of tetrahedral configuration and includes a frame comprised of a rectangular central panel and a pair of triangular side panels. The central panel has a light bulb assembly mounted thereon and a triangular lens is mounted on the frame between the triangular side panels.

8 Claims, 2 Drawing Sheets



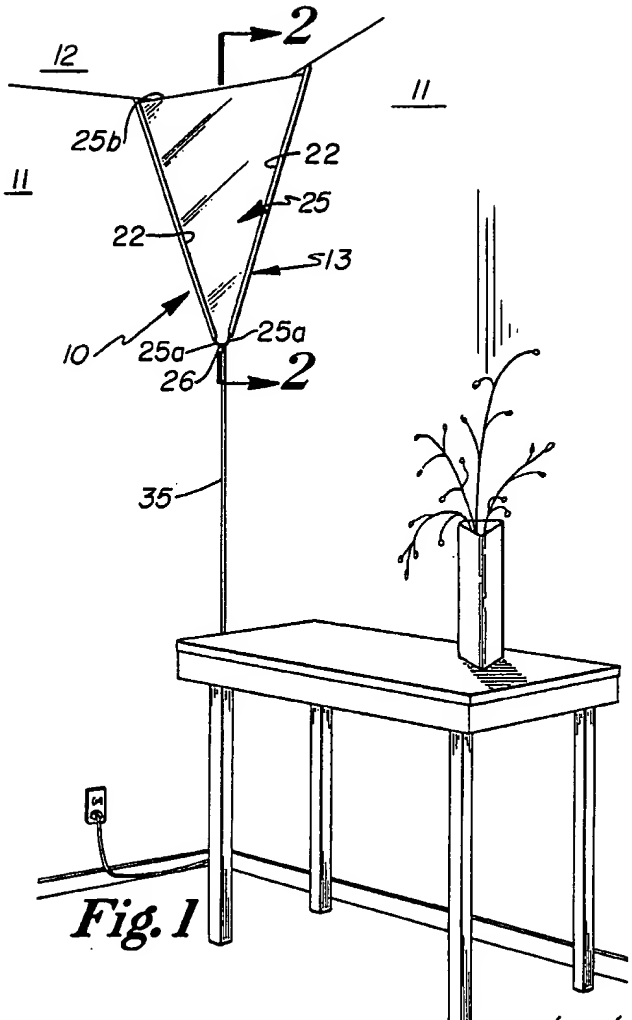


Fig. 1

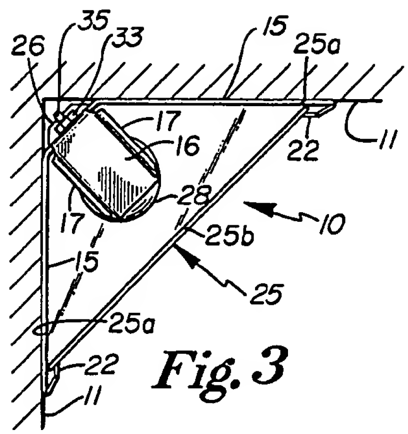


Fig. 3

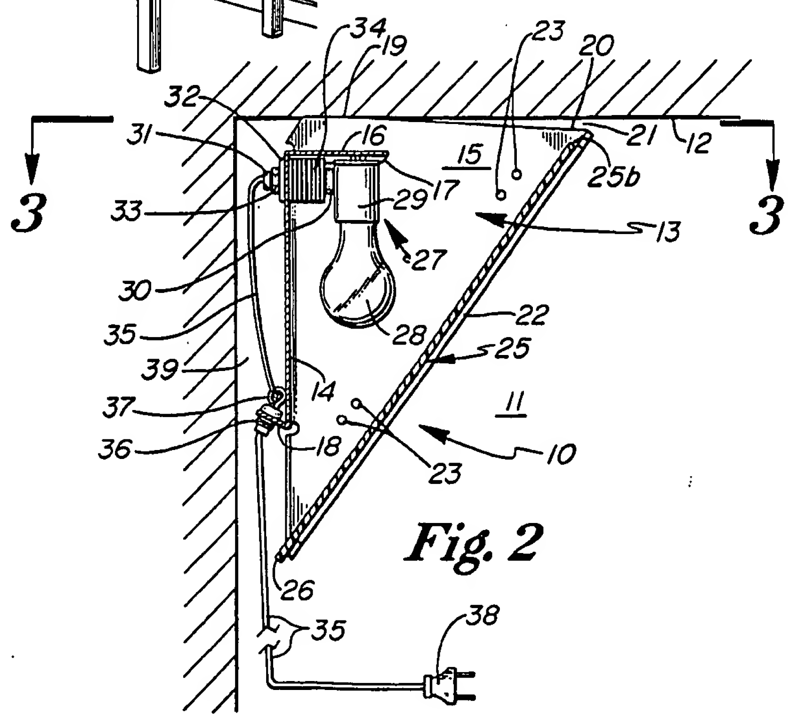


Fig. 2

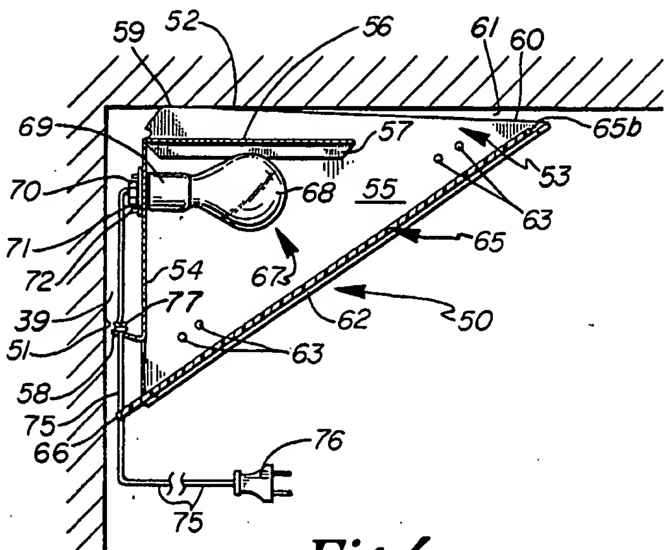


Fig. 4

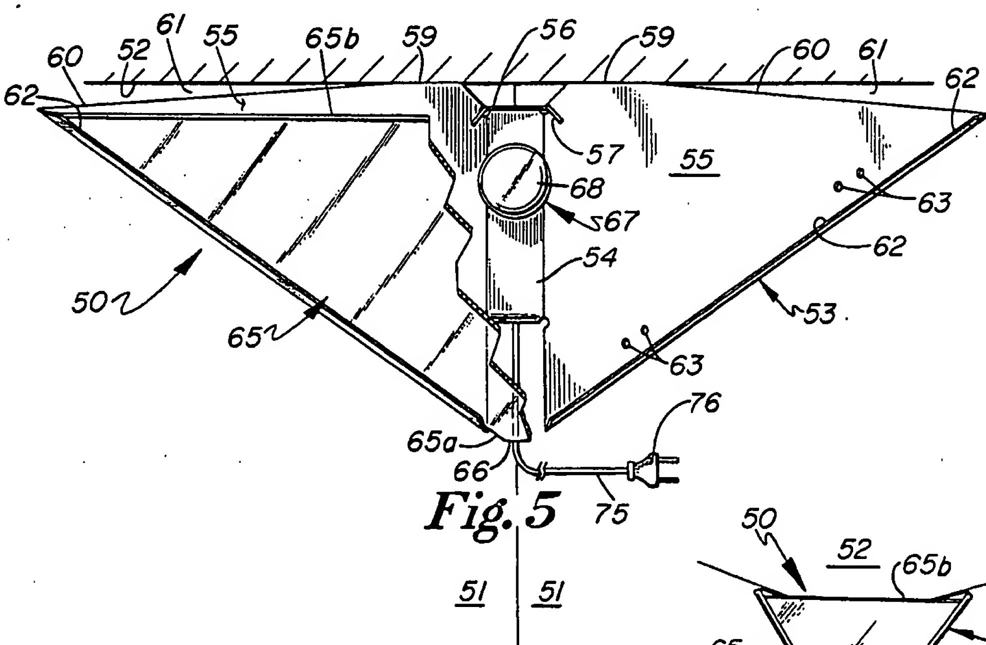


Fig. 5

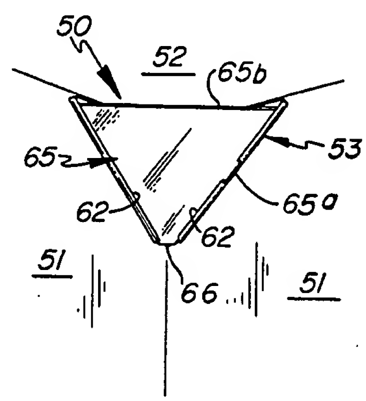


Fig. 6

CORNER WALL LAMP

This invention relates to lamps and, more particularly, to wall lamps.

BACKGROUND OF THE INVENTION

Interior illumination for commercial and domestic buildings is provided by various types of lighting devices. Wall and ceiling lamps are sometimes used, but placement of these prior art wall or ceiling attached lamps does not always provide efficient illumination or aesthetic appeal. Wall lamps, as the name suggests, are mounted on a room wall, but are not usually attached at a corner. There are presently no known commercial corner lamps which may be mounted where the apex of two walls meets the ceiling.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a novel corner lamp, which is designed to be mounted in the corner of a room where two walls meet the ceiling to thereby present an aesthetically appealing lamp and one which permits efficient distribution of the light.

A more specific object of this invention is to provide a novel corner wall lamp of tetrahedral configuration comprising a metal frame and a triangular lens which, when mounted in a room corner at the ceiling, permits effective diffusion of light therefrom.

Another object of this invention is to provide a novel corner wall lamp of tetrahedral configuration, including a metal frame, which engages a pair of orthogonally disposed walls and ceiling, and which is provided with a flap that overlies the light bulb to protect the ceiling from excessive heat input.

A further object of this invention is to provide a corner wall lamp of tetrahedral configuration, including a triangular-shaped lens mounted on a metal frame comprised of a pair of triangular-shaped side panels and a central panel which provides a space at the room corner behind the frame. The central panel has several functions, namely: it spaces the frame away from the wall corner to allow installation of the frame upon walls in which the corner may be appreciably rounded, rather than square; it provides a mounting surface for a socket; and the space behind the panel permits routing the electrical wiring behind the panel, thereby shielding the wiring from the heat of the bulb.

These and other objects will be more fully defined in the following Specification.

FIGURES OF THE DRAWING

FIG. 1 is a perspective view of the novel corner wall lamp illustrated in mounted relation in a room corner;

FIG. 2 is a cross-sectional view taken approximately along the line 2—2 of FIG. 1 and looking in the direction of the arrows;

FIG. 3 is a top view taken approximately along the line 3—3 of FIG. 2 and looking in the direction of the arrows;

FIG. 4 is a cross-sectional view of a modified form of the novel lamp and corresponding generally to FIG. 2;

FIG. 5 is a front elevational view of the lamp illustrated in FIG. 4 with the lens partially broken away; and

FIG. 6 is a front perspective view of the lamp illustrated in FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings and, more specifically, to FIGS. **1**, **2**, and **3**, it will be seen that one embodiment of the novel corner lamp, designated generally by the reference numeral **10**, is there shown. It will be noted that the corner lamp **10** is mounted in the corner of a room at the apex where two walls **11** meet at the ceiling **12**. In the preferred embodiment of the novel corner lamp, it is assumed that the walls **11** and ceiling **12** are arranged in orthogonal relationship with respect to each other. However, it is pointed out that the design of the corner lamp may be modified for use in conjunction with walls and ceilings that do not necessarily meet at 90-degree angles.

It will be seen that the volumetric space defined by the novel lamp **10** defines a tetrahedron. In this respect, if a skewed plane intercepts three other mutually intersecting planes, such intersection creates four triangles which define and bound a pyramidal volume, i.e., spatially, a tetrahedron. All four sides of this volumetric space are triangles: one on each wall, one triangle comprising the corner of the ceiling, and one triangle facing into the room.

Referring again to FIGS. **1**, **2**, and **3**, it will be seen that the novel corner lamp **10** includes a frame **13** formed of a heat-resistant and reflective lightweight material, such as white-enameled aluminum, or other similar materials. The frame **13** includes a generally rectangularly-shaped central panel **14** having a pair of similar triangular-shaped side panels **15** integrally formed therewith and extending outwardly therefrom. When the lamp **10** is mounted in the corner, the triangular side panels lie flat upon both walls. The central panel **14** is also spaced from the corner defined by the orthogonally related walls.

The central panel **14** has an upper flap **16** integrally formed therewith and extending forwardly in right angular relation thereto. The upper flap **16** has flanges **17** integral therewith and extending downwardly therefrom. The lower end portion of the central panel **14** has a flap **18** integrally formed therewith and extending rearwardly therefrom. It is pointed out that the flap **18** has an opening therethrough for passage of electrical wiring. The upper flap **16** deflects heat energy radiated directly upwardly by the lamp bulb and socket, which prevents damage or discoloration of the ceiling from excessive heat input.

Referring now to FIG. **2**, it will be seen that the triangular side panels have an upper edge **19** which engages the ceiling **12** along a portion of its length. However, it will be noted that the upper edge **19** has a slightly downwardly extending front portion **20** that defines an opening **21** between the top of the lens **25*b*** and the ceiling **12**. This allows the circulation of heated air and thereby prevents overheating of the ceiling and lamp. The dimension of the clearance **21** is dependent upon the size of the lamp and the size of the maximum light bulb properly associated therewith. Each lamp size has a specified maximum wattage lamp bulb to be used in each lamp, and such maximum size is prominently marked by decal or stencil on each lamp. The clearance afforded by dimension **21**, in conjunction with proper triangle size, is built into each lamp and includes a large safety factor for the kind of misuse which may be expected in service, namely, use some times of larger than specified bulbs. The safety factor is

such that no deterioration of the socket or wiring will occur in the event of misuse, but is such that for gross misuse the triangle will visibly deform. The clearance is typically one inch, being somewhat more than one inch for larger wattage lamps and less than one inch for smaller wattage lamps.

Each triangular side panel 15 has an inturned flange 22 integral therewith and converging towards the inturned flange on the other side panel, as best seen in FIG. 1. It will also be noted in FIGS. 2 and 3 that the side flanges 22 extend downwardly and inwardly towards the associated corner. The side panels are provided with a plurality of small openings 23 therethrough for accommodating small nails, which are used to secure the side panels to the associated walls 11.

A triangular-shaped lens 25 formed of a rigid translucent material, having suitable optical properties, is engaged by the frame so that the inclined side edges 25*a* of the lens 25 engage the side panels and are supported by flanges 22. When the lens 25 is mounted on the frame, the edge portions 25*a* of the lens tend to urge the side panels 15 against the associated wall 11. It will be noted that the upper edge 25*b* of the lens 25 is spaced by the dimension 21 below the surface of the ceiling 12 when the lens is in supported relation on the frame 13. The lower end portion of the lens 25 is truncated, as at 26. The clearance 21 between the upper edge 25*b* and the ceiling permits the outflow of hot air and also allows one to remove the lens in order to change the light bulb. This clearance also permits some indirect lighting as a result of reflection of light outwardly through the clearance opening into the room, thereby enhancing the total light efficiency.

Referring again to FIG. 2, it will be seen that the tetrahedral lamp 10 is provided with an incandescent light bulb assembly 27 which is secured to the central panel 14. The incandescent light bulb assembly includes an incandescent light bulb 28 of predetermined desired wattage which is threaded into a female socket member 29. In this regard, the socket member 29 is a suitable heat-resistant commercial model, which is selected to tolerate operating temperatures without degradation. The socket member 29 is provided with an internally threaded sleeve 30 that threadedly engages a nipple 31, which projects through an opening in the central panel 14. A washer 32 and nut 33 secure the incandescent light bulb assembly 27 to the central panel. In the embodiment shown, a plurality of spacers 34 are disposed between the internally threaded sleeve 30 and the front surface of the central panel 14 to properly position the light bulb for optimum results. It will also be noted that the length of the flap 16 is of a magnitude related to the thickness of the spacer stack 34 so that the flap overlies light bulb 28 and socket 29.

The incandescent light bulb assembly 27 also includes a two-wire cord 35 which extends downwardly through the space 39 defined behind the central panel 14. The two-wire cord 35 is formed into a knot 37, which engages a grommet 36 positioned within the opening in the rearwardly extending flap 18. The cord 35 extends through the opening and is provided with a conventional two-prong or three-prong male connector 38 at its other end for ready connection to a conventional outlet. The knot 37 prevents stress or force applied to the dangling cord from being transmitted to the wire connected within the lamp socket, as is customary in lamp design. The clearance space 39 behind the central panel 14 not only allows the cord 35 to pass downwardly behind the lamp frame, protected from the bulb heat, but also allows the installation of the lamp at corners which are not truly orthogonally related.

Referring now to FIGS. 4, 5, and 6, it will be seen that a modified form of the novel tetrahedral lamp is thereshown and is designated generally by the reference numeral 50. The tetrahedral lamp 50 is also attached to orthogonally disposed walls 51 at their intersection with the ceiling 52. The lamp 50 includes a frame 53, which is comprised of a generally rectangular-shaped central panel 54 having a pair of similar triangular-shaped side panels 55 integrally formed therewith and projecting therefrom. The central panel 54 has an upper flap 56 integrally formed therewith and projecting forwardly at right angles relative thereto. The flap 56 is provided with downturned flanges 57, as best seen in FIG. 5. The lower end portion of the central panel 54 is bent rearwardly and upwardly to define an upturned flap 58 having an opening therein.

The upper flap 56 of the central panel 54 also serves as a shield to prevent heat from the incandescent light from being radiated upwardly and causing damage or discoloration to the ceiling. It is also pointed out that, while both embodiments of the lamp described hereinabove have included protective flaps or shields to prevent damage to the ceiling, the flap may be omitted by mounting the incandescent lamp assembly at a lower location with respect to the frame.

Each of the side panels 55 is provided with an upper edge 59, which engages the ceiling 52. Again, it will be noted that the front portion of each upper edge is downwardly declined, as at 60, to define a space or opening 61 between the ceiling and the top of the lens 65*b*. This space 61 allows hot air to escape from the interior of the lamp and prevents overheating. It is again pointed out that the exact dimension of this downwardly extending front portion will be dependent on the wattage of the bulb used. The side panels 55 are also each provided with an inturned flange 62 and these flanges converge inwardly in the manner of the embodiments of FIGS. 1, 2, and 3. Each side panel also has a plurality of small openings 63 therein for accommodating nails, which secure the side panels to the walls.

The lamp is provided with a generally triangular-shaped translucent lens 65 formed of material of suitable mechanical, thermal, and optical properties. The inclined side edges 65*a* of the lens engage the side panels 55 of the frame and urge the side panels against the vertical walls of the room. The lower end portion of the lens is truncated, as at 66, and it will be noted that the upper edge 65*b* of the lens is spaced slightly from the ceiling 52. This clearance 61 between the ceiling and the upper edge of the lens is necessary to permit the outflow of hot air, the removal of the lens when it is desirable to replace a bulb, and permits some indirect lighting. With respect to indirect lighting, some of the light is reflected outwardly to the room from the ceiling without passing through the lens.

The tetrahedral lamp 50 also includes an incandescent light bulb assembly 67 and an incandescent light bulb 68 of the desired wattage. It will be noted that the light bulb assembly 67 also includes a commercial socket member 69, which is internally threaded for accommodating the light bulb 68. The socket member 69 is a commercial type and is heat-resistant in the manner of the embodiment of FIGS. 1, 2, and 3 for operating at selected temperatures without degradation.

Means are provided for securing the socket member to the central panel 54. In this regard, the socket member 69 is provided with a pair of bolts 72 which pass through openings in the central panel and threadedly engage in threaded bores in a flange 71, which is integral with a sleeve 70. The sleeve 70 is disposed in registering relation with an opening in the central panel 54 through which the two-wire cord extends. The flange 71 and bolts 72 clamp the socket member against the front surface of the panel 54. The incandescent light bulb assembly includes a two-wire cord 75, which is provided with a male connector 76, at its other end. The male connector may be either the two-prong or three-prong type, as desired for connection to a conventional wall outlet. The two-wire cord 75 has a knot 77 tied therein, which engages the flap 58 as the cord passes through the opening in the latter. The knot 77 prevents stress or force applied to the dangling cord from being transmitted to the wire connected within the lamp socket. A grommet is provided at the opening in the flap 58. The detail of this grommet in flap 58 is identical to the grommet 36 in flap 18 in FIG. 2.

By way of comparison, it will be noted that the lamp illustrated in FIGS. 1, 2, and 3 has a greater ratio of verical dimension to width, while the converse is true with respect to the lamp disclosed in FIGS. 4, 5, and 6. In this regard, dimensions referred to are the height and width of the triangular lens, as viewed in planform. The width dimension is the width of the upper edge of the triangular lens. The vertical dimension is the height of the lens, measured prior to truncation of the lower tip of the triangle.

The two configurations shown feature either vertical or horizontal mounting of the light bulb, based upon the value of the rato as defined above. If the height-to-width ratio is greater than 0.8, the included bulb is mounted vertically, as shown in the lamp embodiment 10 in FIGS. 1, 2, and 3. If the height-to-width ratio of the triangular lens is less than 0.8, the included bulb is mounted horizontally, as shown in the lamp embodiment 50 in FIGS. 4, 5, and 6. This differentiation, based on a ratio of 0.8, provides the best spatial accommodation of standard size incandescent light bulbs within the enclosed volume. Consequently, a wide range of efficient lamp configurations may be provided, varying in size so as to accommodate large or small bulbs, and varying in height-to-width ratio as desired, either for reason of space availability or for reason of aesthetic choice. Each configuration will spatially define a tetrahedron.

It will be seen that my novel corner lamp, while having a general tetrahedral shape, may vary otherwise in size and configuration. It will also be noted that my novel corner lamp may be readily mounted in a corner at the ceiling, regardless of whether the walls have a perfect or imperfect orthogonal relationship.

It will also be seen from the preceding paragraphs and the attached FIGS. 1–6 that my novel tetrahedral lamp is not only effective in providing good efficient light distribution, but it is also highly aesthetically appealing to the eye.

Thus, it will be seen that my novel tetrahedral lamp is not only of simple and inexpensive construction, but one which functions in a more efficient manner than any heretofore known comparable lamp, as a consequence of unique and original utilization of an aspect of a room geometry.

What is claimed is:

1. A tetrahedral corner lamp for attachment to the corner of a room defined by the orthagonal relation of a pair of walls and the ceiling of the room, comprising:
- a metal frame formed of a heat resistant, light reflective material and including a generally rectangular-shaped vertically extending central panel and a pair of triangular-shaped side panels integral with said central panel and extending angularly outwardly therefrom,
- means of attaching the triangular side panels to the associated vertical walls defining the corner,
- said triangular side panels each having an upper edge with a portion thereof engaging the ceiling and having a front outer edge bent to define an inturned flange, said inturned flange on one side panel inclined towards the inturned flange on the other side panel,
- a light bulb socket connected with said central panel and projecting forwardly therefrom between said triangular side panels, a light bulb mounted in said socket, an elongate two-wire electrical cord having one end thereof connected to said socket and extending downwardly therefrom and having a male socket member secured to the other end thereof for connection to an electrical outlet, said triangular side panels and said central panel defining reflective surfaces for reflecting light outwardly of said frame, and
- a triangular-shaped translucent lens positioned between said side panels in contact therewith having an apex extending downwardly, engaging and supported by said flanges and urging each of said triangular side panels against the adjacent associated vertical wall.

2. The tetrahedral lamp as defined in claim 1 wherein said upper edge of each triangular side panel includes a relieved portion which defines a lens-to-ceiling clearance opening with respect to the ceiling when the upper edge engages the ceiling.

3. The tetrahedral lamp as defined in claim 1 wherein said lens has a substantially straight upper edge spaced downwardly from the ceiling.

4. The tetrahedral lamp as defined in claim 3 wherein the bulb is mounted vertically for lamps with a lens having a height-to-width ratio greater than 0.8.

5. The tetrahedral lamp as defined in claim 3 wherein the bulb is mounted horizontally for lamps with a lens having a height-to-width ratio less than 0.8.

6. The tetrahedral lamp as defined in claim 1 wherein said central panel of said metal frame is of such as rectangular shape that it will extend at an angle across the corner of a room between adjoining walls on which said side panels are mounted, whereby said central panel will be spaced outwardly from the room corner and define therewith a triangular space between the wall and metal frame within which said electrical cord may extend downwardly.

7. A tetrahedral corner lamp for attachment to the corner of a room defined by the orthagonal relation of a pair of walls and the ceiling of the room, comprising:
- a metal frame including a generally rectangular-shaped central panel and a pair of triangular-shaped side panels integral with said central panel and extending angularly outwardly therefrom,
- means for attaching the triangular side panels to the associated vertical walls defining the corner,
- said triangular side panels each having an upper edge with a portion thereof engaging the ceiling and

having a front outer outermost edge bent to define an inturned flange, said inturned flange on one side panel inclined and angled towards the inturned flange on the other side panel,

a light bulb socket connected with said central panel and projecting forwardly therefrom between said triangular side panels, said socket being spaced downwardly from the ceiling, an elongate two-wire electrical cord having one end thereof connected to said socket and extending downwardly therefrom and having a male socket member secured to the other end thereof for connection to an electrical outlet, and

a triangular-shaped translucent lens positioned between said side panels in contact therewith having an apex extending downwardly and engaging and being supported by said flanges and urging each of said triangular side panels against the adjacent associated vertical wall.

8. A tetrahedral corner lamp for attachment to the corner of a room defined by the orthagonal relation of a pair of walls and the ceiling of the room, comprising:

a metal frame including a generally rectangular-shaped central panel and a pair of triangular-shaped side panels integral with said central panel and extending angularly outwardly therefrom said central panel having a horizontally disposed flap

integral therewith and projecting forwardly therefrom,

means for attaching the triangular side panels to the associated vertical walls defining the corner,

said triangular side panels each having an upper edge with a portion thereof engaging the ceiling and having a front outer edge bent to define an inturned flange, said inturned flange on one side panel inclined towards the inturned flange on the other side panel,

a light bulb socket connected with said central panel and projecting forwardly therefrom between said triangular side panels, said horizontal flap overlying and shielding a light bulb installed in said socket and being of such dimensions to intercept heat energy radiated by the light bulb and to prevent damage to the ceiling, said socket being spaced downwardly from the ceiling, an elongate two-wire electrical cord having one end thereof connected to said socket and extending downwardly therefrom and having a male socket member secured to the other end thereof for connection to an electrical outlet, and

a triangular-shaped translucent lens positioned between said side panels in contact therewith having an apex extending downwardly and engaging said flanges and urging each of said triangular side panels against the adjacent associated vertical wall.

* * * * *

US00D354973S

United States Patent [19]

Hisatune et al.

[11] **Patent Number: Des. 354,973**

[45] **Date of Patent: ** Jan. 31, 1995**

[54] **SURVEILLANCE VIDEO CAMERA**

[75] Inventors: **Toshiyuki Hisatune**, Yokohama; **Shigemitsu Kizawa; Kouji Shindou**, both of Tokyo, all of Japan

[73] Assignee: **Sony Corporation**, Tokyo, Japan

[**] Term: **14 Years**

[21] Appl. No.: **6,716**

[22] Filed: **Apr. 5, 1993**

[30] **Foreign Application Priority Data**

Oct. 7, 1992 [JP] Japan 4-29286

[52] **U.S. Cl.** **D16/203**; 348/143

[58] **Field of Search** D14/100; D16/200–204; 348/143, 373–376; 352/242; 354/64, 65, 76, 288, 293

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Primary Examiner—Bernard Ansher
Assistant Examiner—Adir Aronovich
Attorney, Agent, or Firm—Jay H. Maioli

[57] **CLAIM**

The ornamental design for a surveillance video camera, as shown and described.

DESCRIPTION

FIG. 1 is a top, front and right-side perspective view of a surveillance video camera, showing our new design;
FIG. 2 is a front elevational view thereof;
FIG. 3 is a rear elevational view thereof;
FIG. 4 is a right-side elevational view thereof, the left-side being a mirror image thereof;
FIG. 5 is a top plan view thereof; and,
FIG. 6 is a bottom plan view thereof.

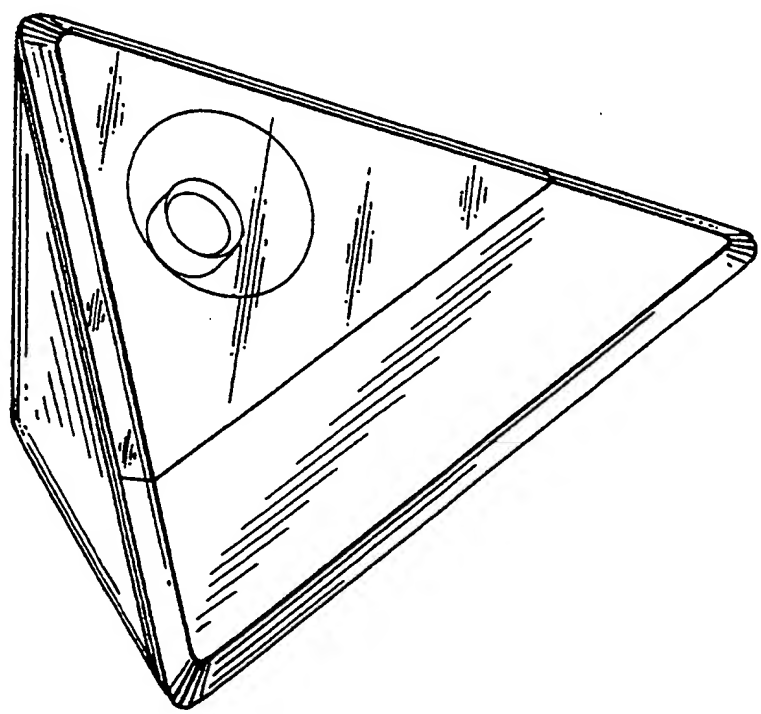


FIG. 1

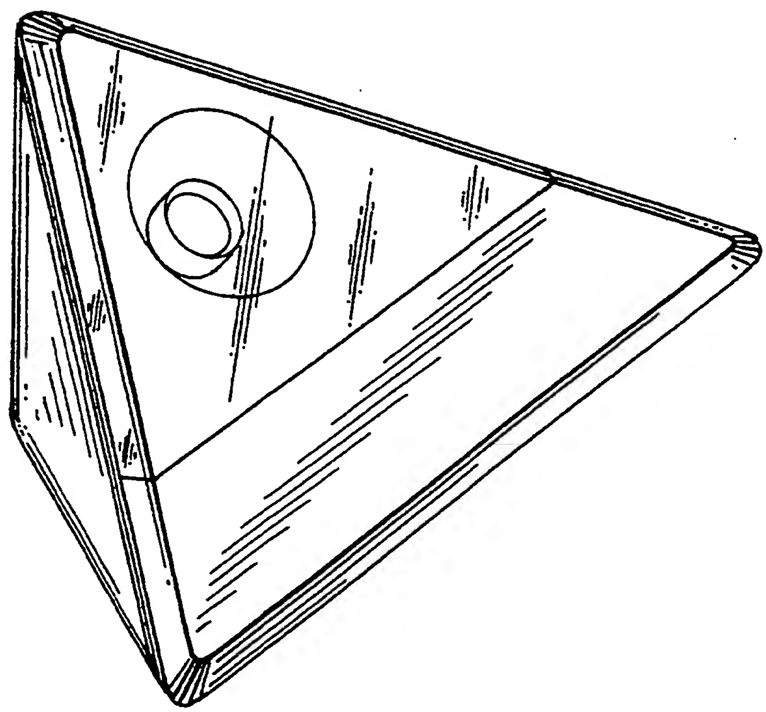
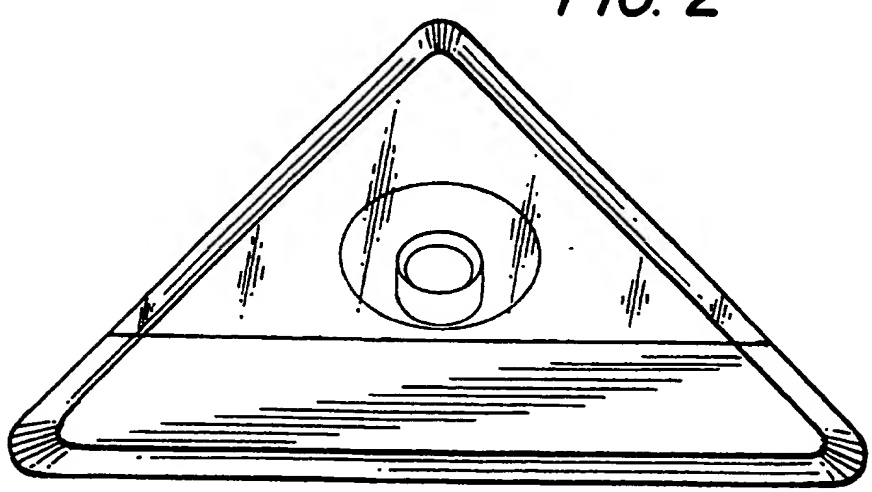


FIG. 2



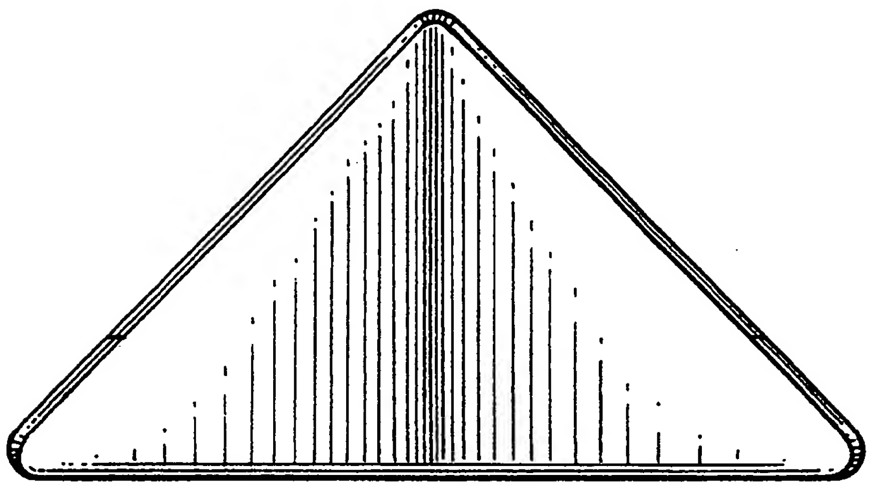


FIG. 3

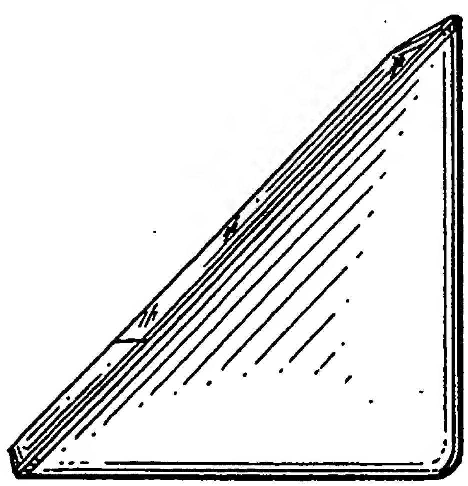


FIG. 4

FIG. 5

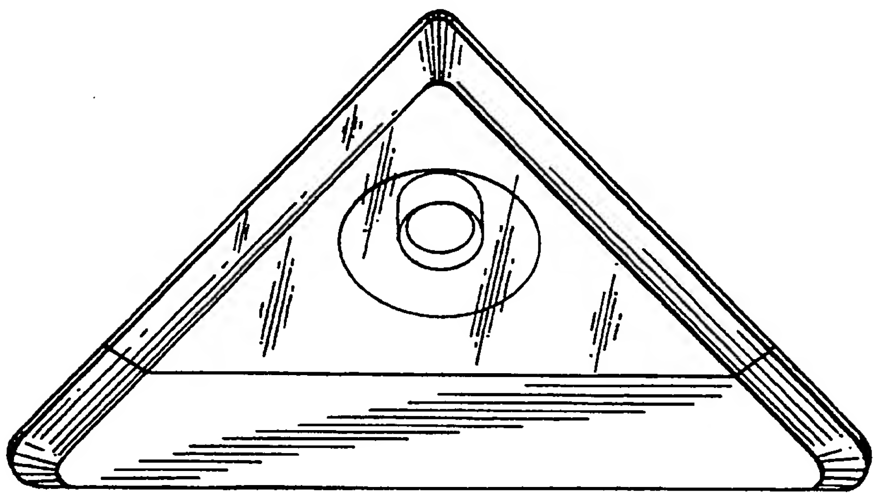
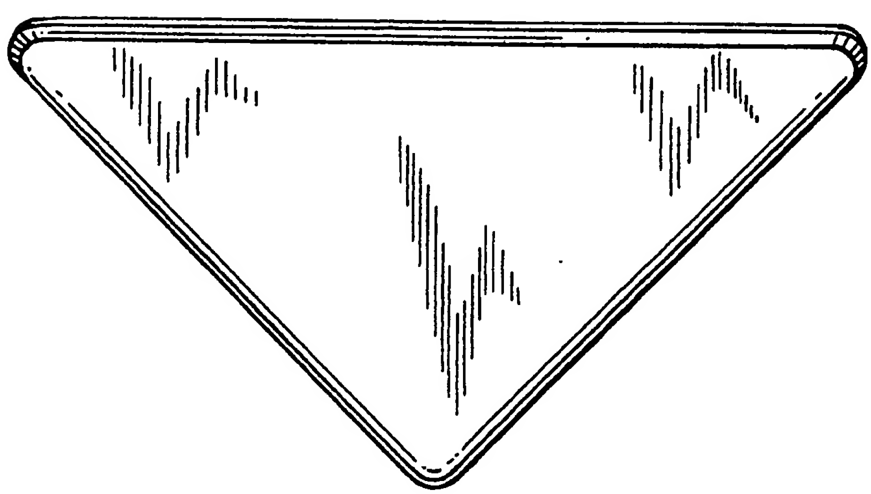


FIG. 6



United States Patent [19]
Wright

[11] **Patent Number:** **4,972,633**
[45] **Date of Patent:** **Nov. 27, 1990**

[54] **CORNER-MOUNTED SHIELD**

[76] Inventor: **Darrow D. Wright**, 6926 Lehring Rd., Bancroft, Mich. 48414

[21] Appl. No.: **371,204**

[22] Filed: **Jun. 26, 1989**

[51] **Int. Cl.**⁵ **E04F 19/04**

[52] **U.S. Cl.** **52/27**; 358/108; 248/220.1; 248/466; 52/288

[58] **Field of Search** 52/288, 27, 28, 39; 40/646; 248/220.1, 475.1, 466; 312/238; 358/108, 229; 354/81, 293; 352/242, 243

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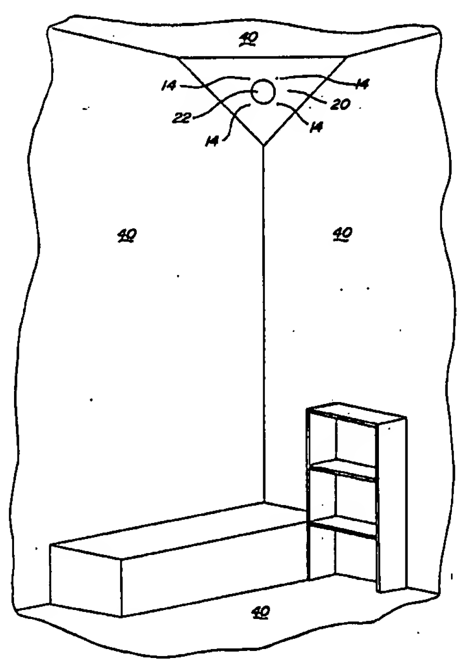
Primary Examiner—John E. Murtagh
Assistant Examiner—Jerrold D. Johnson
Attorney, Agent, or Firm—Krass & Young

[57] **ABSTRACT**

A corner-mounted shield for protecting monitoring devices includes a triangular protective plate attached to three adjacent corner-forming interior room surfaces (e.g. two walls and ceiling). Attachments to the corner-forming interior room surfaces are made behind the protective plate, usually through an opening in the protective plate, and are inaccessible after the opening is covered by a window. The window is attached to the protective plate with tamper-resistant fasteners and is essentially transparent to whatever is being monitored by the monitoring device. The monitoring device, mounted behind the protective plate and window, has a clear view of the monitored room through the window because the protective plate faces into and is within the monitored room.

23 Claims, 3 Drawing Sheets



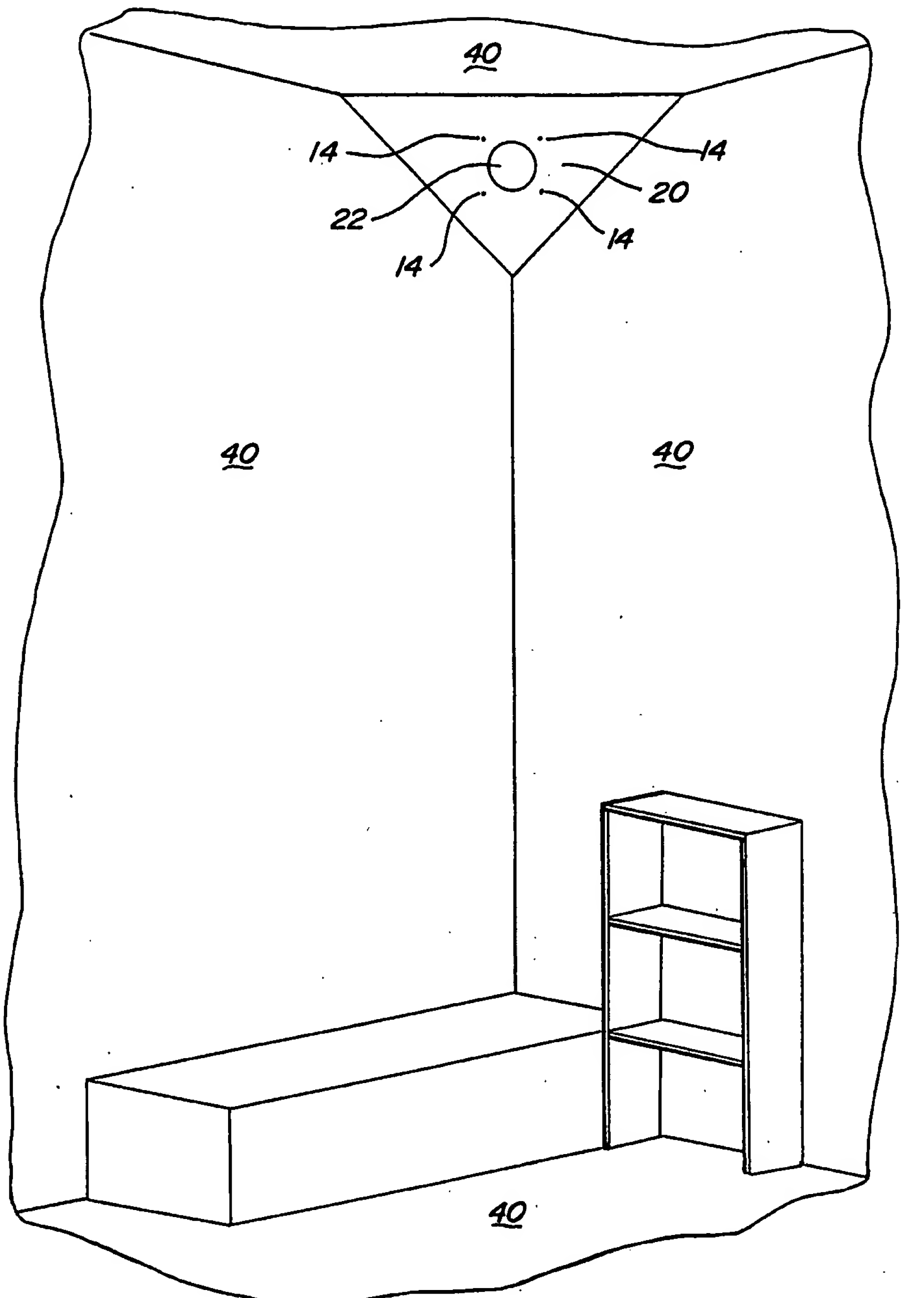


Fig-1

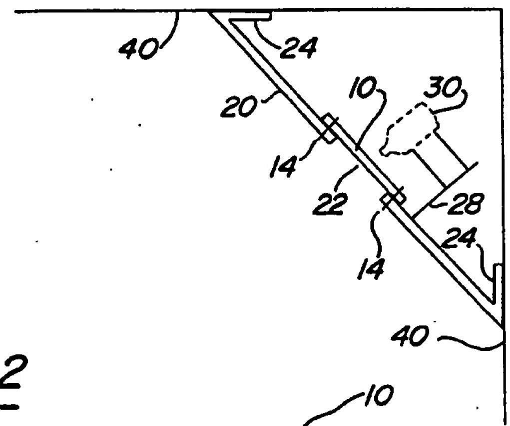


Fig-2

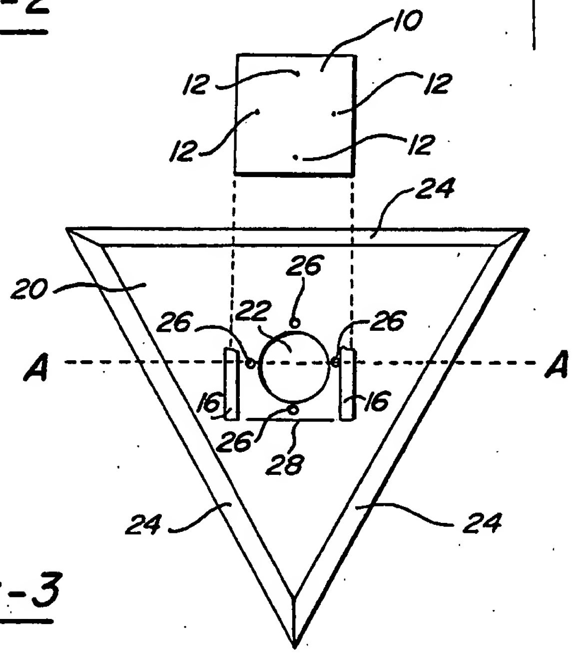


Fig-3

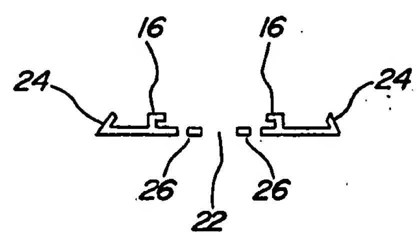


Fig-3A

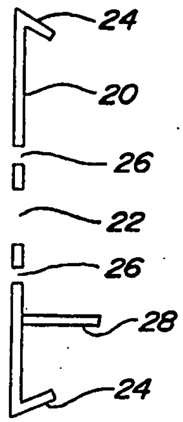


Fig-4A

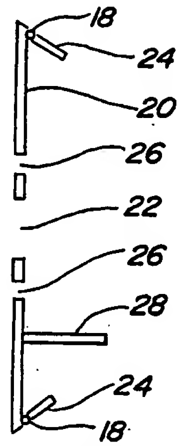


Fig-4B

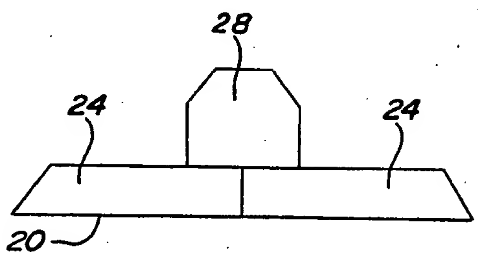


Fig-5

CORNER-MOUNTED SHIELD

FIELD OF THE INVENTION

This invention relates to shields used to protect room or area monitoring devices.

BACKGROUND OF THE INVENTION

Protection of devices used to monitor rooms or areas, such as jail cells or lobbies, has been effected by either building a viewing port into a wall so the monitoring device may view the room or area through the viewing port, or by mounting the monitoring device outside the room so the monitoring device may view the room through gaps in a barrier, such as cell bars.

Building a viewing port into the wall of a room when the room is being constructed requires providing a tamper-resistant protective housing for the monitoring device outside of the room to be monitored. The associated monitoring device must be located inside the protective housing, which is behind the wall. Thus the monitoring device is unlikely to have a clear view of the entire room because room areas adjacent to the wall (through which the viewing port is mounted) tend to be behind the view of the monitoring device.

Refitting a viewing port into a constructed room includes the problem of making a hole of significant size in an existing room wall and fitting it with a viewing port. It also involves the task of finding a tamper-resistant secure place, outside of the monitored room, to mount the monitoring device.

The scheme of mounting the monitoring device outside the room, so it has a view of the inside of the room through gaps in a barrier, such as the bars of a cell, is often a viable alternative to use with rooms already constructed. Even so, the view of the room provided to the monitoring device is impaired as portions of a room most distant from the monitoring device tend to be occluded and inevitably blind spots occur both because of the barrier in front of the monitoring device and because the monitoring device is partially blocked by the wall in front of it.

In the cases noted above, the task of finding a place for the monitoring device may prove insurmountable as suitable places may not exist outside the room to be monitored. In the above cases, the monitoring device must be protected from tampering both from within and from without the monitored room, and thus the monitoring device must be mounted inside an armored, tamper-resistant housing with a transparent tamper-resistant viewing port. Because of the wide variety of places where such housings are to be placed, little standardization of housings is possible. At present, protection of monitoring devices, if a location to place a monitoring device can be found, requires substantial construction and results in limited performance.

The new corner-mounted shield overcomes the above limitations as:

it is straightforward to add during room construction or to add to already constructed rooms because it is pre-manufactured as a standard item and is placed in an available room corner using conventional fasteners;

it provides the monitoring device a view of the entire room because of the unobstructed view resulting from the viewing port facing into the room from a corner and because the internally located monitoring device is capable of being closer than an externally located monitoring device to the most distant part of the room; and

it is inherently resistive to tampering because the wall attaching fasteners are inaccessible and the window attaching fasteners are tamper resistant.

SUMMARY OF THE INVENTION

It is the object of this invention to provide a novel way to protect monitoring devices, such as those used in jails, prisons, environmentally hazardous areas, or lobbies, with an attractive, easily installed, tamper resistant, corner-mounted shield that provides the monitoring device with a clear view of the area to be monitored.

A BRIEF DESCRIPTION OF THE DRAWINGS

One will better understand the present invention by referring to the following detailed description while consulting the accompanying drawings, where the same reference numerals are used to refer to the same parts throughout the several views, and in which:

FIG. 1 is a perspective view of the corner-mounted shield as seen by an observer within the room monitored.

FIG. 2 is a cross section view of the corner-mounted shield showing a monitoring device looking through the window, and the protective plate's attachment to interior room surfaces.

FIG. 3 is a rear view of the protective plate and detached window with dashed lines showing where the window is placed.

FIG. 3A is a cross section view through line A—A of FIG. 3.

FIG. 4A is a side cross section view of the protective plate showing the inclination of rigidly attached mounting brackets, opening, apertures for fasteners used to attach the window, and the platform.

FIG. 4B is the same as FIG. 4A where the mounting brackets are flexibly attached with hinges.

FIG. 5 is a bottom view of the protective plate showing the mounting brackets and platform.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE PRESENT INVENTION

A person inside of a room being monitored would have a view of the shield much like that provided by FIG. 1. Such a person would see a triangular protective plate **20** flush mounted in a room corner formed by three adjacent interior room surfaces **40** and a window **10** flush mounted behind an opening **22** in the protective plate **20**. The only visible or accessible fasteners are tamper-resistant fasteners **14** disposed about the opening **22** and used to attach the window **10** to the protective plate **20**. Behind the window **10**, a monitoring device **30** is placed so it may view the room.

FIG. 2 shows, in a side view of the shield, how most of the shield's components are arranged when it is mounted in a room corner formed by three adjacent interior room surfaces **40**. The shield is composed of two main parts, a protective plate **20** and a window **10**. The protective plate **20** is triangular, has a centrally located opening **22**, holding channels **16** (not visible on FIG. 2), mounting brackets **24**, apertures for fasteners **26** (not visible on FIG. 2), and a platform **28** for supporting a monitoring device **30**. The window **10** is essentially transparent to whatever is monitored by the monitoring device **30** and has fastener attachment sites

12 (not visible on FIG. 2) for the tamper-resistant fasteners 14. The mounting brackets 24 are attached to the interior room surfaces 40 thereby affixing the protective plate 20. The window 10 is attached to the back of the protective plate 20 with tamper-resistant fasteners 14 passing through apertures for fasteners 26 into fastener attachment sites 12. A monitoring device 30 is attached to the platform 28 and may face directly, and without obstruction, through window 10 into the monitored room.

FIG. 3 shows, in a rear view of the shield, how the shield's main parts are arranged and shows the components previously not shown. The fastener attachment sites 12 on the window 10 and the apertures for fasteners 26 on the protective plate 20 are arranged so they are aligned with each other when the window 10 is to be attached to the protective plate 20. The attachment is effected by passing a tamper-resistant fastener 14 (not shown in FIG. 3) through each aperture for fastener 26 to a fastener attachment site 12. The holding channels 16 are deployed on each side of the opening 22 and, along with the platform 28, serve to hold the window 10. The holding is especially useful while the window 10 is being attached. The cross section view of FIG. 3A shows the shape and placement of the holding channels 16, apertures for fasteners 26, opening 22, and mounting brackets 24 on the protective plate 20. In the preferred embodiment, the protective plate 20 is made of metal, and, as shown on FIG. 4A, the mounting brackets 24 are rigidly attached to the protective plate 20 and so inclined as to be flush with the interior room surfaces 40 when the shield is placed in a corner. The platform 28 is attached below the opening 22 essentially perpendicular to the protective plate 20 and, as shown on FIG. 5, extends far enough so as to furnish a convenient support for a monitoring device 30. The window 10, for optical monitoring, is made of the clear polycarbonate resin material sold by General Electric under the trademark "LEXAN" because of its excellent transparency to white light, high impact resistance relative to glass, hardness, and resistance to scratching. The fastener attachment sites 12 on the window 10 align with the apertures for fasteners 26 in the protective plate 20 when the window 10 is attached to the protective plate 20 with the tamper-resistant fasteners 14, and the fastener attachment sites 12 are appropriate for the particular tamper-resistant fasteners 14 used. The tamper-resistant fasteners 14 may include conventional bolts or screws with their heads ground down after use, rivets, or bolts or screws with their engaging surfaces filled or covered with solder after use.

The shield is mounted by:

placing the window 10 loosely behind the protective plate 20 anywhere where it may be reached through the opening 22 and where it does not interfere or, alternatively, by placing the window 10 loosely between the holding channels 16 and platform 28;

placing the protective plate 20 plus loose window 10 against three interior room surfaces 40 so the mounting brackets 24 are flush to each interior room surface 40; and

attaching the mounting brackets 24 to the interior room surfaces 40 with conventional fastening methods, such as by welding, bolting, or gluing, where such methods may be made effective through the opening 22.

A monitoring device 30, such as a television camera, is placed on the platform 28 so as to be able to view the room through the opening 22. The hitherto loose window 10 is positioned between the opening 22 and the monitoring device 30 flush against the protective plate 20 with each fastener attachment site 12 aligned with each aperture for fastener 26. Then the window 10 is attached using tamper-resistant fasteners 14 passing through each aperture for fastener 26 to a fastener attachment site 12.

An alternative embodiment may be effected by flexibly attaching the mounting brackets 24 to the protective plate 20, as with hinges 18. This alternative is indicated on FIG. 4B, and is appropriate when the three corner-forming interior room surfaces 40 are not mutually orthogonal or it is desired to skew the view through the window 10 provided to the monitoring device 30.

The shield of the present invention is advantageous in a number of different respects.

First, the monitoring device 30 is effectively shield from tampering because the fasteners used to attach the mounting brackets 24 to three corner-forming interior room surfaces 40 are behind the protective plate 20 and thus inaccessible, and because the fasteners used to attach the window 10 to the protective plate 20 are tamper resistant.

The present invention is further advantageous because the shield may be refitted into a room or cell merely by providing communication to the monitoring device 30, most often through a small opening, and attaching the protective plate's mounting brackets 24 to three corner-forming interior surfaces 40. These operations may be performed at low cost using simple tools, even if the walls are made of concrete or masonry. The shield may also be placed in a room during the room's construction with equal ease. The ease of use of the present invention may be contrasted with the alternatives:

The first alternative to the use of this invention requires making a hole in a wall large enough for a viewing port and providing a secure place behind the wall for the monitoring device 30.

The second alternative is to place the monitoring device 30 so it views the room through a barrier, such as cell bars, while being enclosed in a secure housing.

Both of the alternatives require more effort and cost to implement than does the present invention.

A further advantage of the present invention is its ability to provide a clear view of the inside of the monitored room. This is because the protective plate 20, and thus the monitoring device 30, faces into, and is within, the monitored room. Thus all of the room is normally well within the view of the monitoring device 30. In the first alternative to the present invention, described above, it is inherently difficult to place the viewing port so as to provide a clear view of the entire room because areas to the side of the wall-mounted viewing port tend to be behind the view of the monitoring device. The second alternative, described above, also has the problem of some of the room being behind the view of the monitoring device and has some additional blockage due to the intervening barrier. Neither of the alternatives provides as good a view as the present invention wherein essentially none of the room is to the side of the window 10 and there are no intervening barriers to the view of the monitoring device 30.

A still further advantage of the present invention is its pleasing and unobtrusive appearance. In areas such as lobbies, pleasing appearance is important. The shield as a whole is symmetrical, merges smoothly with the

shape of the room, and can be painted to match its surroundings. These properties causes it to be inconspicuous or at least not unpleasant or annoying to an observer.

The present invention, even for new construction, provides a tamper resistant, less expensive, more efficacious, and pleasing solution to the need to protect monitoring devices 30. It is inherently difficult to tamper with, is straightforward to mount, allows a full view, and is easy on the eyes.

Although a preferred embodiment of the invention has been disclosed in detail, it will be recognized that variations or modifications lie within the scope of the present invention.

I claim:

1. A shield for mounting to corner-forming adjacent interior surfaces for protecting monitoring devices, comprising:
- a triangular protective plate having attached mounting brackets and an opening;
- first attaching means for attaching said mounting brackets to corner-forming adjacent interior surfaces;
- means for supporting the monitoring device;
- a window made of an essentially transparent material;
- second attaching means for attaching said window to said protective plate with said window covering said opening.

2. A shield as recited in claim 1, wherein said protective plate is made of metal.

3. A shield as recited in claim 1, wherein said mounting brackets are flexibly attached to said protective plate.

4. A shield as recited in claim 3, wherein said shield further includes hinges for flexibly attaching said mounting brackets to said protective plate.

5. A shield as recited in claim 1, wherein said mounting are rigidly attached to said protective plate.

6. A shield as recited in claim 1, wherein said first attaching means are only accessible through said opening.

7. A shield for mounting to corner-forming adjacent interior surfaces for protecting monitoring devices, comprising:
- a triangular protective plate having attached mounting brackets and a centrally located opening;
- first attaching means for attaching said mounting brackets to corner-forming adjacent interior surfaces;
- a window made of an essentially transparent material, said essentially transparent material being impact resistant and essentially transparent to whatever is monitored by the monitoring device; and
- second attaching means for attaching said window to said protective plate with said window covering said opening.

8. A shield as recited in claim 7, wherein said protective plate is made of metal.

9. A shield as recited in claim 7, wherein said mounting brackets are flexibly attached to said protective plate.

10. A shield as recited in claim 9, wherein said shield further includes hinges for flexibly attaching said mounting brackets to said protective plate.

11. A shield as recited in claim 7, wherein said mounting brackets are rigidly attached to said protective plate.

12. A shield as recited in claim 7, wherein said essentially transparent material includes polycarbonate resin. and essentially transparent to whatever is monitored by the monitoring device.

13. A shield as recited in claim 7, wherein said first attaching means are only accessible through said opening.

14. A shield as recited in claim 7, wherein said second attaching means includes tamper-resistant fasteners.

15. A shield for mounting to corner-forming adjacent interior surfaces for protecting monitoring devices, comprising:
- a triangular protective plate having attached mounting brackets and a centrally located opening;
- attaching means, only accessible through said opening, for attaching said mounting brackets to corner-forming adjacent interior surfaces;
- a window made of an impact resistant material essentially transparent to whatever is monitored by the monitoring device; and
- tamper-resistant fasteners for attaching said window to said plate with said window covering said opening.

16. A shield as recited in claim 15, wherein said protective plate is made of metal.

17. A shield as recited in claim 15, wherein said mounting brackets are flexibly attached to said protective plate.

18. A shield as recited in claim 17, wherein said shield further includes hinges for flexibly attaching said mounting brackets to said protective plate.

19. A shield as recited in claim 15, wherein said mounting brackets are rigidly attached to said protective plate.

20. A shield as recited in claim 15, further including means for supporting the monitoring device.

21. A shield as recited in claim 15, wherein said impact resistant material includes polycarbonate resin.

22. A shield for mounting to corner-forming adjacent interior surfaces for protecting monitoring devices, comprising:
- a monitoring device;
- a triangular protective plate having attached mounting brackets and an opening;
- first attaching means for attaching said mounting brackets to corner-forming adjacent interior surfaces;
- a window made of an essentially transparent material; and
- second attaching means for attaching said window to said protective plate with said window covering said opening.

23. A shield for mounting to corner-forming adjacent interior surfaces for protecting monitoring devices, comprising:
- a triangular protective plate having attached mounting brackets and an opening, said triangular protective plate being made of an inflexible one piece, metal plate;
- first attaching means for attaching said mounting brackets to corner-forming adjacent interior surfaces;
- a window made of an essentially transparent material; and
- second attaching means for attaching said window to said protective plate with said window covering said opening.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 4,972,633

DATED : November 27, 1990

INVENTOR(S) : Wright

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 4, line 18, "shield" should be --shielded--;

Column 5, line 26, ";" should be --; and--;

Column 6, line 3, delete "and essentially transparent to whatever is monitored by";

Column 6, line 4, delete "the monitoring device.".

Signed and Sealed this

Thirty-first Day of March, 1992

Attest:

HARRY F. MANBECK, JR.

Attesting Officer *Commissioner of Patents and Trademarks*